US011772633B2

(12) **United States Patent**
Tsukano et al.

(10) **Patent No.: US 11,772,633 B2**
(45) **Date of Patent: Oct. 3, 2023**

(54) **VEHICLE CONTROL METHOD, VEHICLE SYSTEM, AND VEHICLE CONTROL APPARATUS**

(71) Applicants: **MAZDA MOTOR CORPORATION**, Hiroshima (JP); **IKUTOKU GAKUEN**, Kanagawa (JP)

(72) Inventors: **Takatoshi Tsukano**, Hiroshima (JP); **Shohei Yamada**, Hiroshima (JP); **Daisuke Umetsu**, Hiroshima (JP); **Fuminori Kato**, Hiroshima (JP); **Osamu Sunahara**, Hiroshima (JP); **Masato Abe**, Atsugi (JP); **Makoto Yamakado**, Atsugi (JP); **Yoshio Kano**, Atsugi (JP); **Kazuki Sato**, Hiroshima (JP)

(73) Assignees: **MAZDA MOTOR CORPORATION**, Hiroshima (JP); **IKUTOKU GAKUEN**, Kanagawa (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 420 days.

(21) Appl. No.: **17/273,723**

(22) PCT Filed: **Sep. 4, 2019**

(86) PCT No.: **PCT/JP2019/034754**
§ 371 (c)(1),
(2) Date: **Mar. 4, 2021**

(87) PCT Pub. No.: **WO2020/054535**
PCT Pub. Date: **Mar. 19, 2020**

(65) **Prior Publication Data**

US 2021/0339735 A1 Nov. 4, 2021

(30) **Foreign Application Priority Data**

Sep. 10, 2018 (JP) 2018-168656

(51) **Int. Cl.**
B60W 30/045 (2012.01)
B60W 10/04 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***B60W 30/045*** (2013.01); ***B60W 10/04*** (2013.01); ***B60W 10/18*** (2013.01); ***B60W 10/20*** (2013.01); *B60W 2510/20* (2013.01)

(58) **Field of Classification Search**
CPC B60W 30/045; B60W 10/04; B60W 10/18; B60W 10/20; B60W 2510/20;
(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

2012/0179349 A1* 7/2012 Yamakado B60W 30/045 701/89
2013/0110366 A1* 5/2013 Suzuki B60K 17/344 701/69
(Continued)

FOREIGN PATENT DOCUMENTS

JP 5143103 B2 2/2013

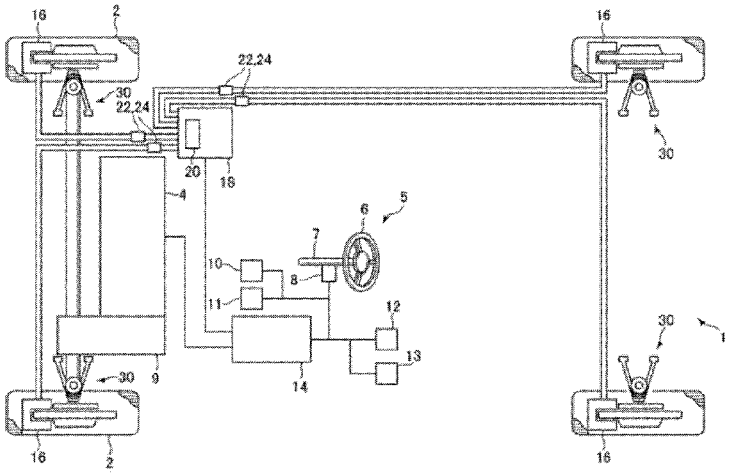
OTHER PUBLICATIONS

International Preliminary Report on Patentability and Written Opinion issued in PCT/JP2019/034754; dated Mar. 9, 2021.
(Continued)

Primary Examiner — Jonathan M Dager
Assistant Examiner — Jean W Charleston
(74) *Attorney, Agent, or Firm* — Studebaker & Brackett PC

(57) **ABSTRACT**

A vehicle control method is applied to a vehicle **1** in which a front wheel **2** is driven by an engine **4**, and the method includes a basic torque setting step of setting basic torque to be generated by the engine **4**, based on an operational state of the vehicle **1**; an acceleration torque setting step of setting
(Continued)



acceleration torque, based on a reduction in steering angle of a steering apparatus **5** mounted on the vehicle **1**; a torque generation step of controlling the engine **4** so that torque based on the basic torque and the acceleration torque is generated; and an acceleration torque changing step of changing the acceleration torque, based on a vehicle-width-direction mounting position of a steering wheel **6** and an operation direction of the steering wheel **6** when the steering angle is reduced. Thus, vehicle posture control is performed in consideration of the vehicle-width-direction mounting position of the steering wheel **6** and the operation direction of the steering wheel **6**, so that a driver fatigue reduction effect of the vehicle posture control can be secured appropriately.

7 Claims, 11 Drawing Sheets

(51) **Int. Cl.**
B60W 10/18 (2012.01)
B60W 10/20 (2006.01)

(58) **Field of Classification Search**
CPC B60W 2520/10; B60W 2520/105; B60W 2540/10; B60W 2540/12; B60W 30/18145; B60W 2540/18; B60W 2710/0666; B60W 2710/0672; B60W 2710/182; B60W 10/06; B60W 10/184
USPC 701/41
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2014/0222309	A1	8/2014	Yamakado et al.	
2015/0336587	A1*	11/2015	Inoue	B60W 30/045 701/1
2017/0129480	A1*	5/2017	Sunahara	B60W 30/18145
2017/0129489	A1*	5/2017	Pawlicki	B60W 30/143
2019/0023257	A1*	1/2019	Doering	F16H 61/688
2019/0135262	A1*	5/2019	Gaither	B60W 20/10

OTHER PUBLICATIONS

International Search Report issued in PCT/JP2019/034754; dated Nov. 5, 2019.

* cited by examiner

FIG. 1

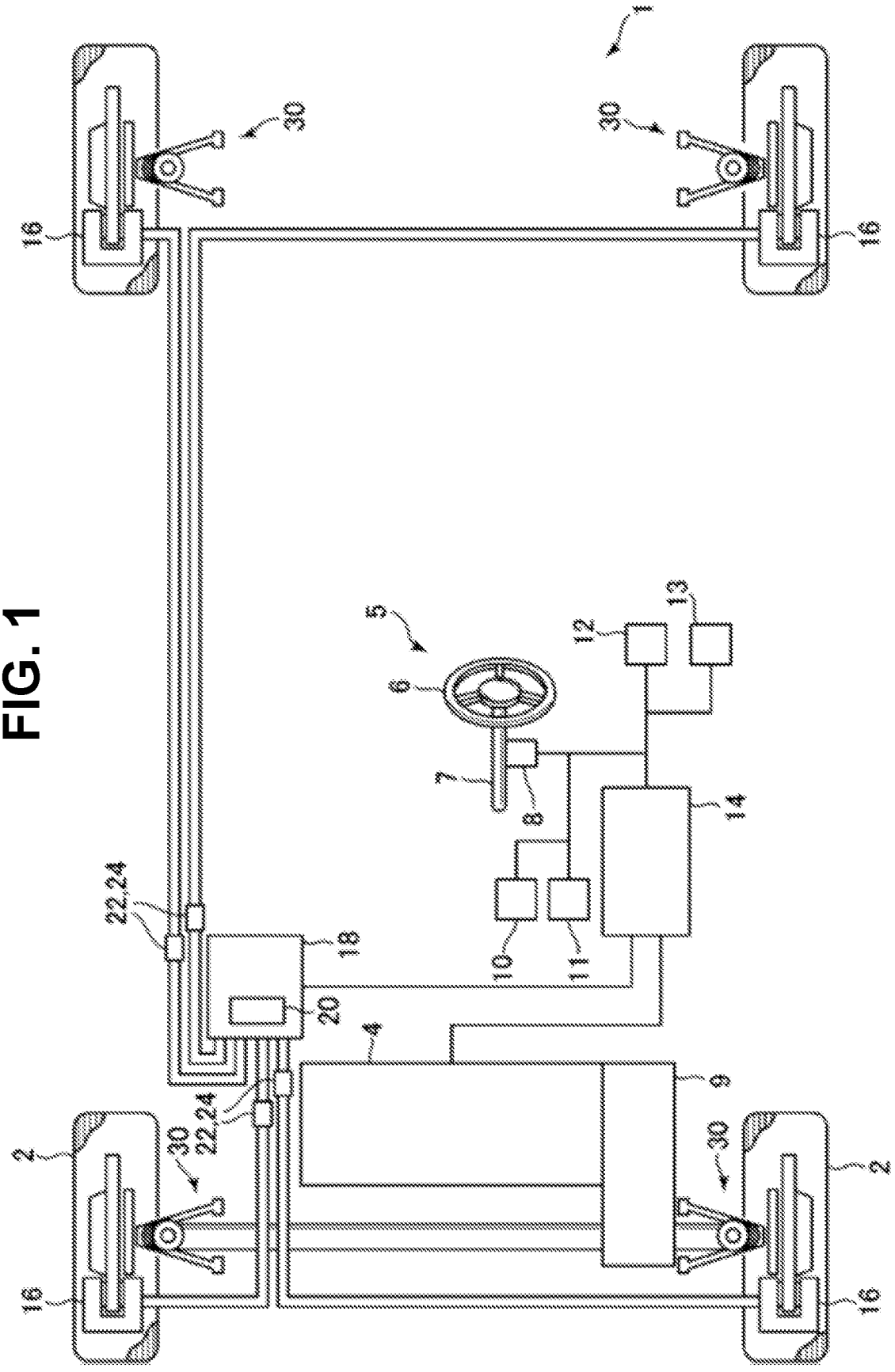


FIG. 2

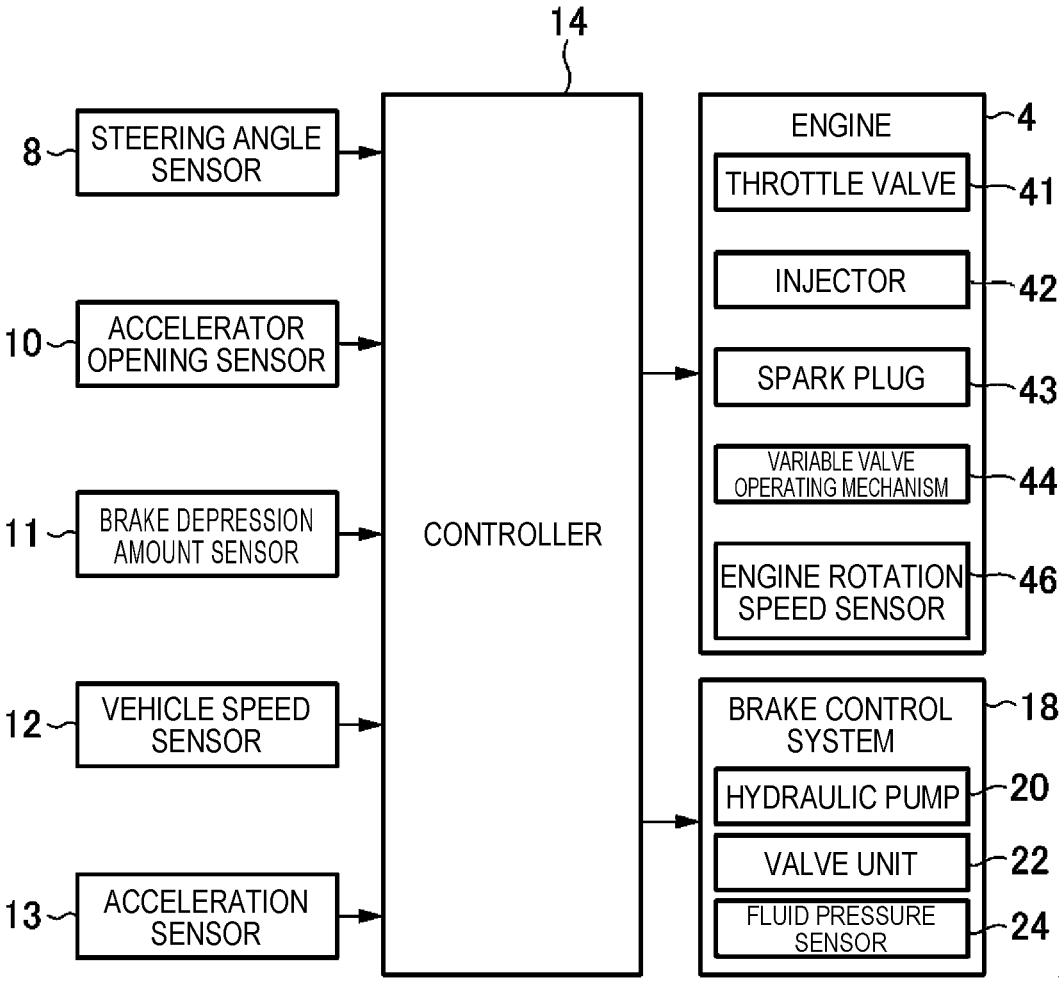

14
8
STEERING ANGLE SENSOR
10
ACCELERATOR OPENING SENSOR
11
BRAKE DEPRESSION AMOUNT SENSOR
12
VEHICLE SPEED SENSOR
13
ACCELERATION SENSOR
CONTROLLER
ENGINE
4
THROTTLE VALVE
41
INJECTOR
42
SPARK PLUG
43
VARIABLE VALVE OPERATING MECHANISM
44
ENGINE ROTATION SPEED SENSOR
46
BRAKE CONTROL SYSTEM
18
HYDRAULIC PUMP
20
VALVE UNIT
22
FLUID PRESSURE SENSOR
24

FIG. 3

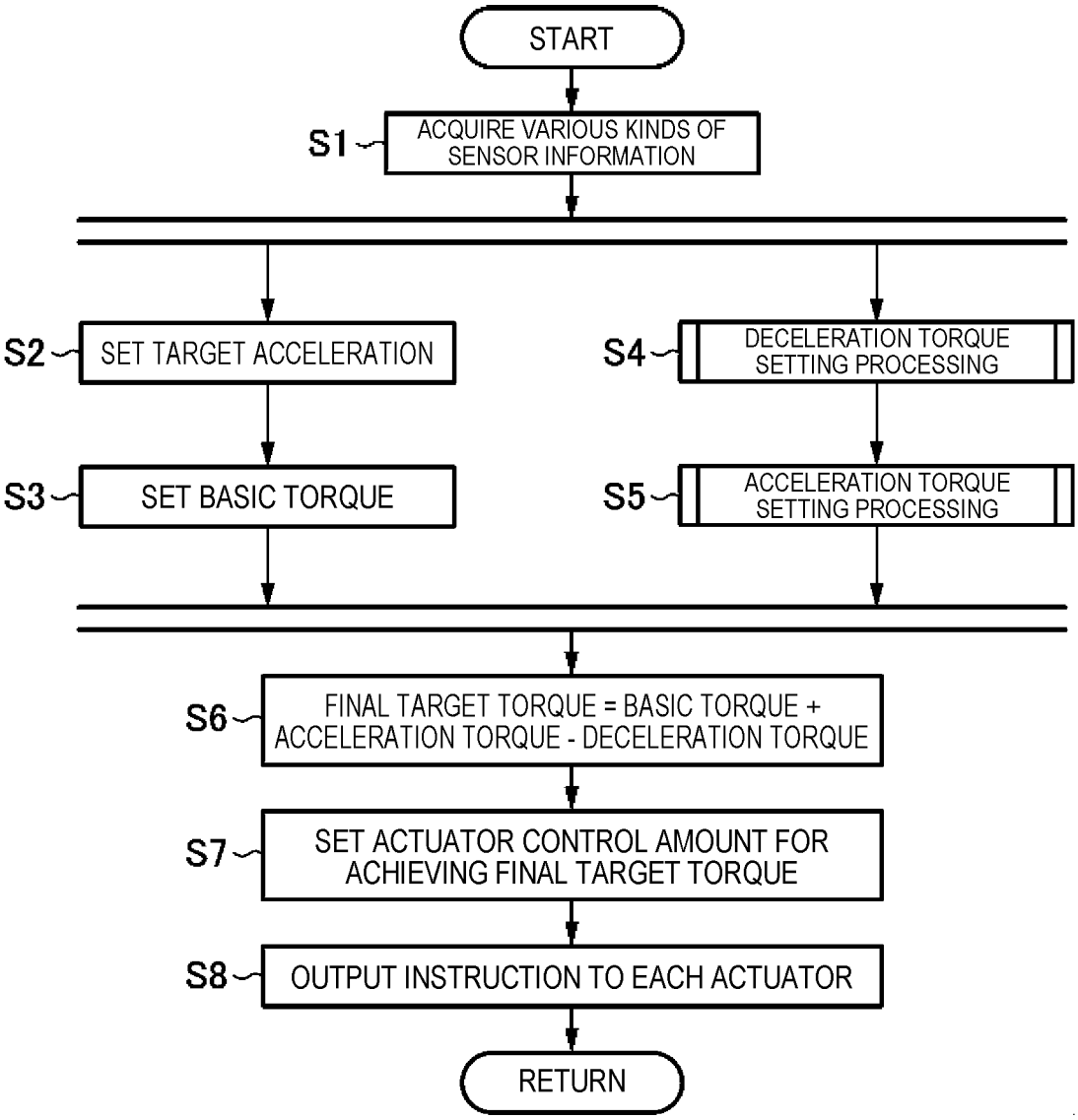

START
S1
ACQUIRE VARIOUS KINDS OF SENSOR INFORMATION
S2
SET TARGET ACCELERATION
S3
SET BASIC TORQUE
S4
DECELERATION TORQUE SETTING PROCESSING
S5
ACCELERATION TORQUE SETTING PROCESSING
S6
FINAL TARGET TORQUE = BASIC TORQUE + ACCELERATION TORQUE - DECELERATION TORQUE
S7
SET ACTUATOR CONTROL AMOUNT FOR ACHIEVING FINAL TARGET TORQUE
S8
OUTPUT INSTRUCTION TO EACH ACTUATOR
RETURN

FIG. 4

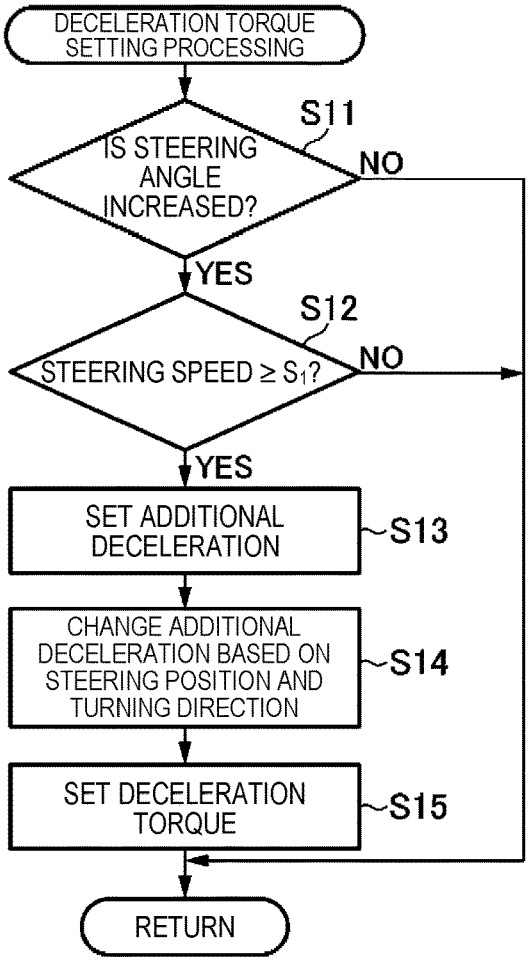

DECELERATION TORQUE SETTING PROCESSING
S11
IS STEERING ANGLE INCREASED?
NO
YES
S12
STEERING SPEED ≥ S1?
NO
YES
SET ADDITIONAL DECELERATION
S13
CHANGE ADDITIONAL DECELERATION BASED ON STEERING POSITION AND TURNING DIRECTION
S14
SET DECELERATION TORQUE
S15
RETURN

FIG. 5

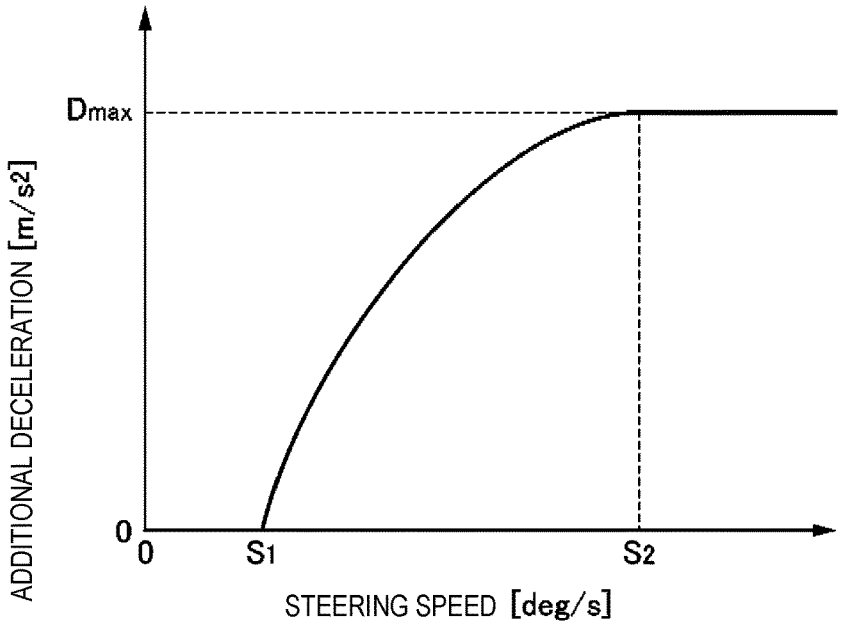

Dmax
0
0
S1
S2
ADDITIONAL DECELERATION [m/s2]
STEERING SPEED [deg/s]

FIG. 6

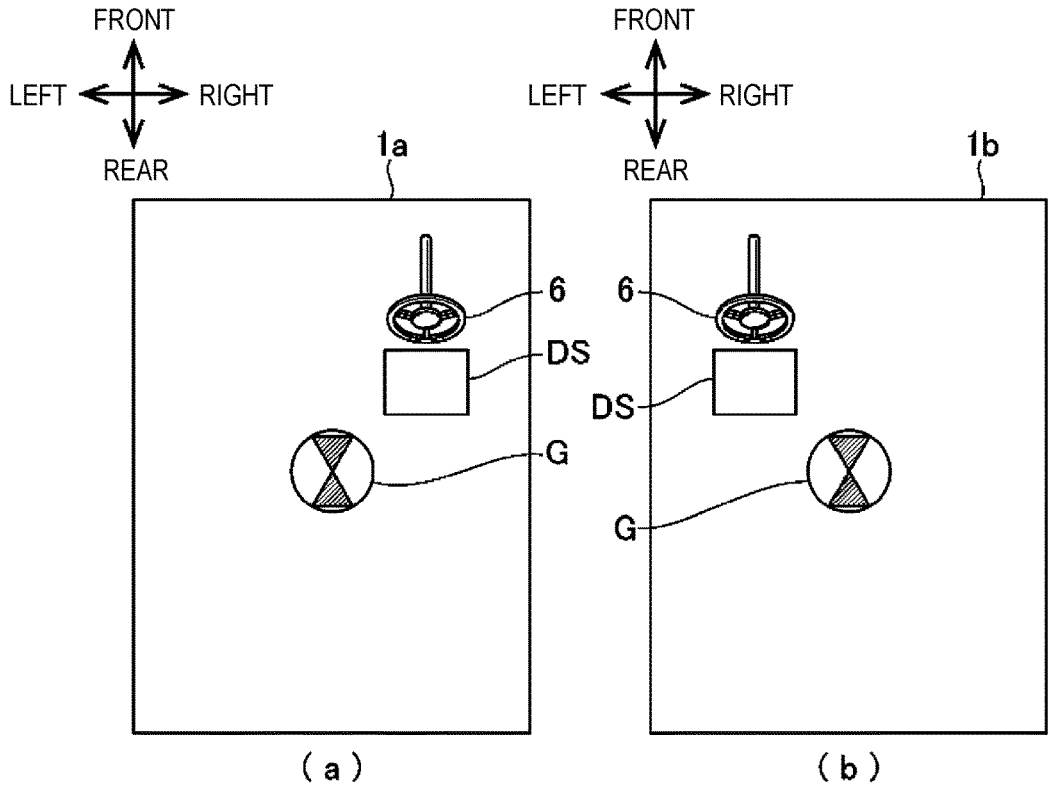

FRONT
LEFT
RIGHT
REAR
1a
6
DS
G
(a)
FRONT
LEFT
RIGHT
REAR
1b
6
DS
G
(b)

FIG. 7

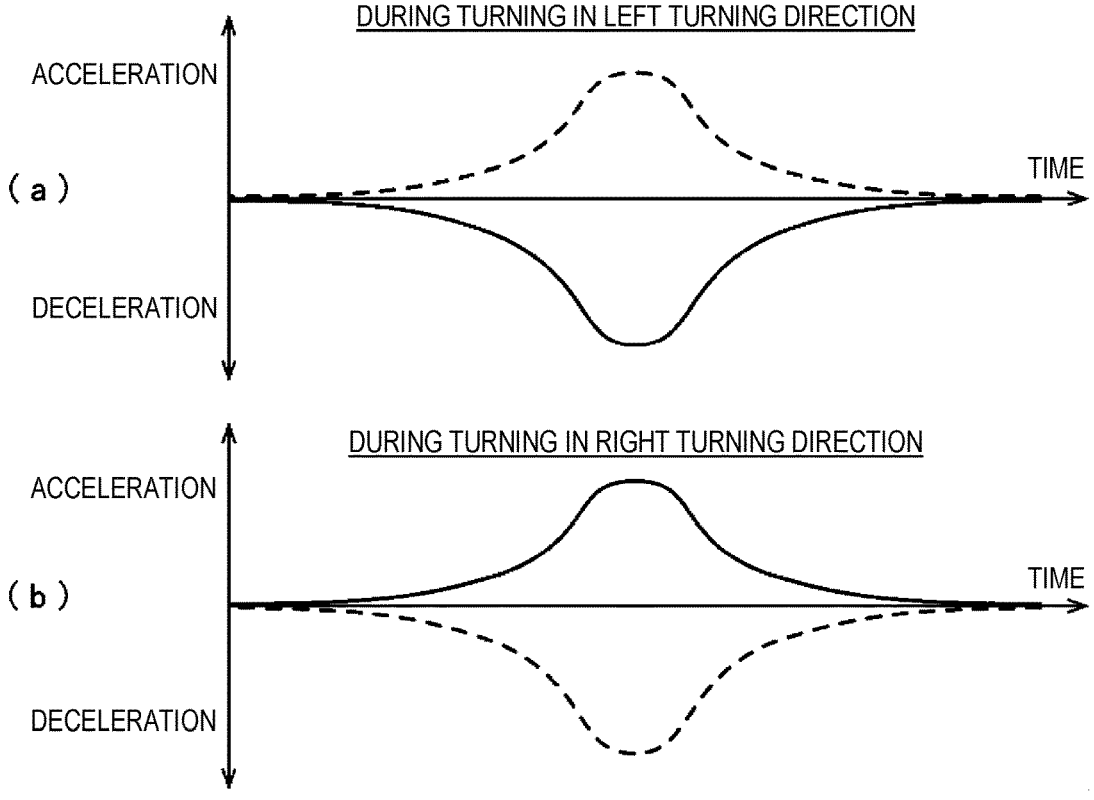

DURING TURNING IN LEFT TURNING DIRECTION
ACCELERATION
(a)
TIME
DECELERATION
DURING TURNING IN RIGHT TURNING DIRECTION
ACCELERATION
(b)
TIME
DECELERATION

FIG. 8

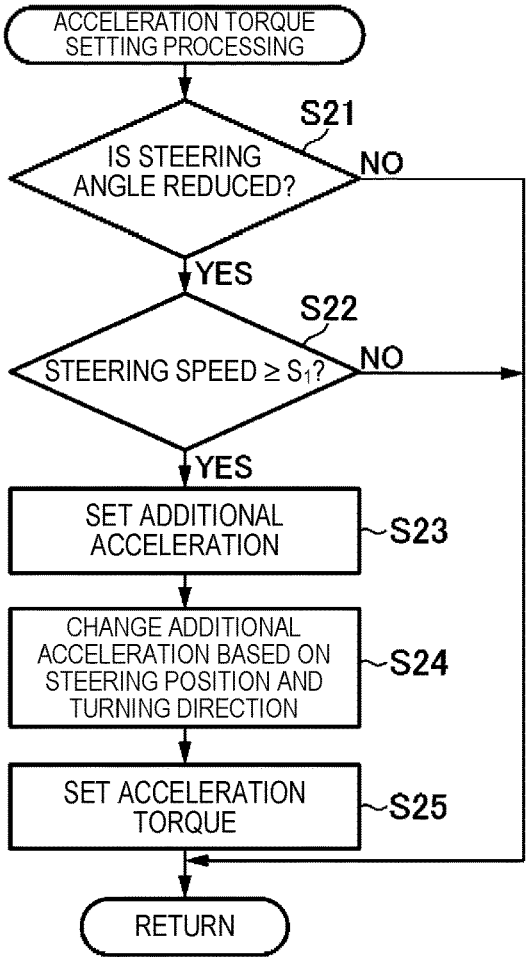

ACCELERATION TORQUE SETTING PROCESSING
S21
IS STEERING ANGLE REDUCED?
NO
YES
S22
STEERING SPEED ≥ S1?
NO
YES
SET ADDITIONAL ACCELERATION
S23
CHANGE ADDITIONAL ACCELERATION BASED ON STEERING POSITION AND TURNING DIRECTION
S24
SET ACCELERATION TORQUE
S25
RETURN

FIG. 9

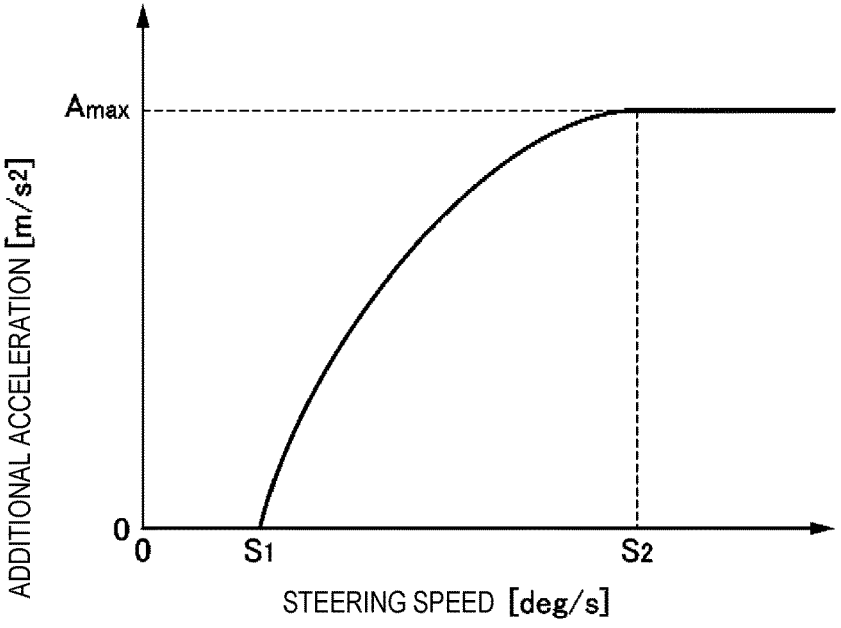

Amax
0
0
S1
S2
ADDITIONAL ACCELERATION [m/s2]
STEERING SPEED [deg/s]

FIG. 10

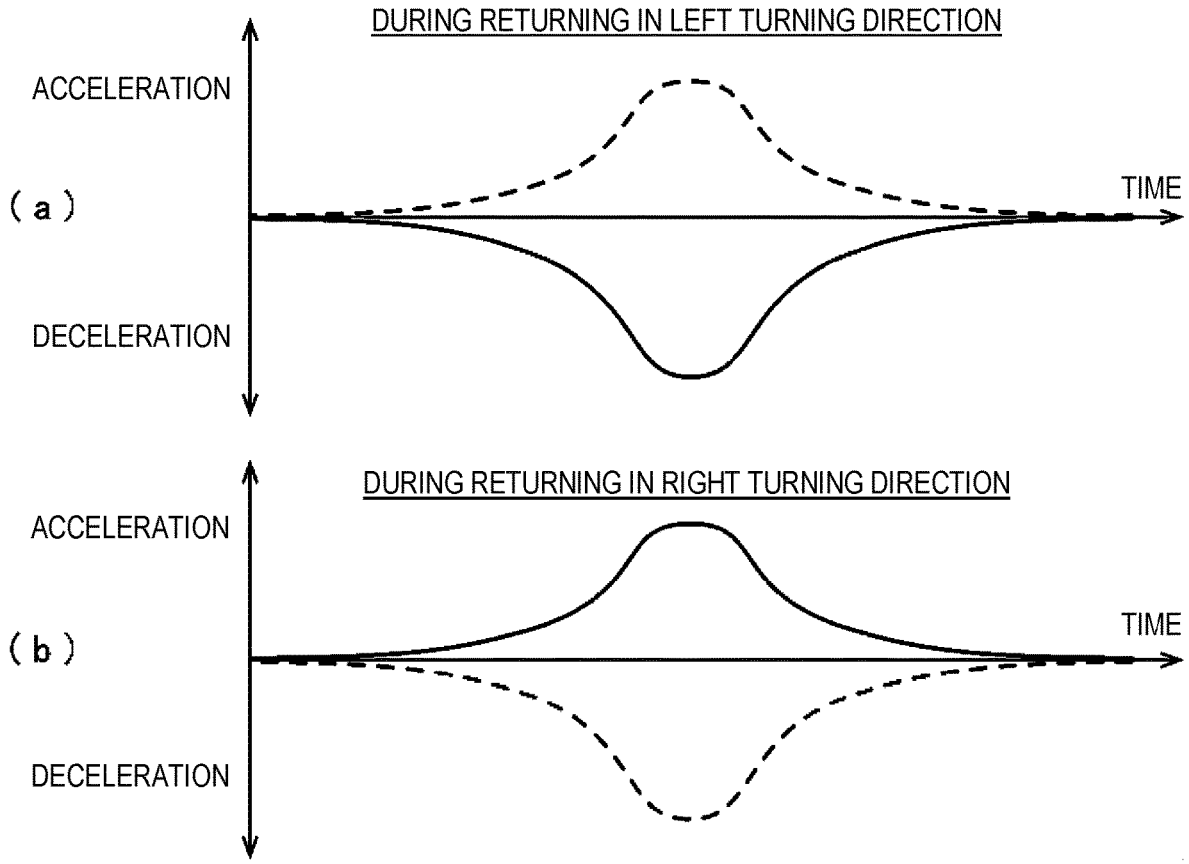

DURING RETURNING IN LEFT TURNING DIRECTION
ACCELERATION
TIME
(a)
DECELERATION
DURING RETURNING IN RIGHT TURNING DIRECTION
ACCELERATION
TIME
(b)
DECELERATION

FIG. 11

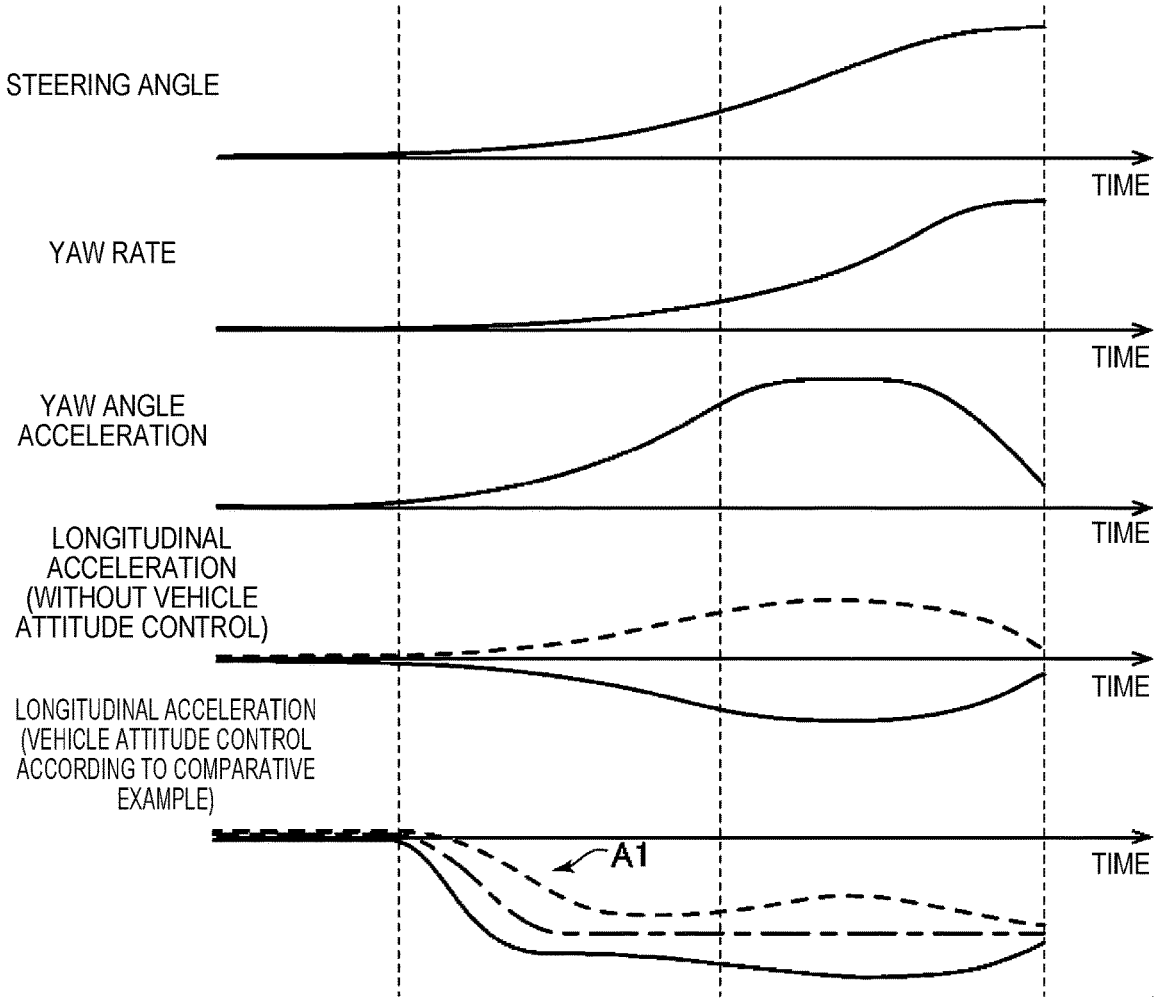

STEERING ANGLE
TIME
YAW RATE
TIME
YAW ANGLE ACCELERATION
TIME
LONGITUDINAL ACCELERATION (WITHOUT VEHICLE ATTITUDE CONTROL)
TIME
LONGITUDINAL ACCELERATION (VEHICLE ATTITUDE CONTROL ACCORDING TO COMPARATIVE EXAMPLE)
A1
TIME

FIG. 12

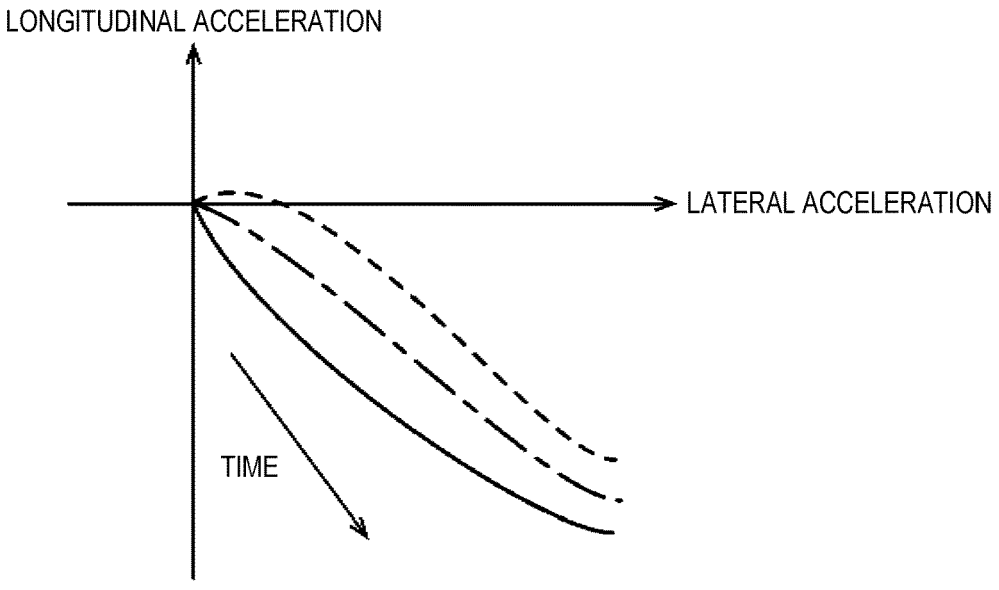

LONGITUDINAL ACCELERATION
LATERAL ACCELERATION
TIME

FIG. 13

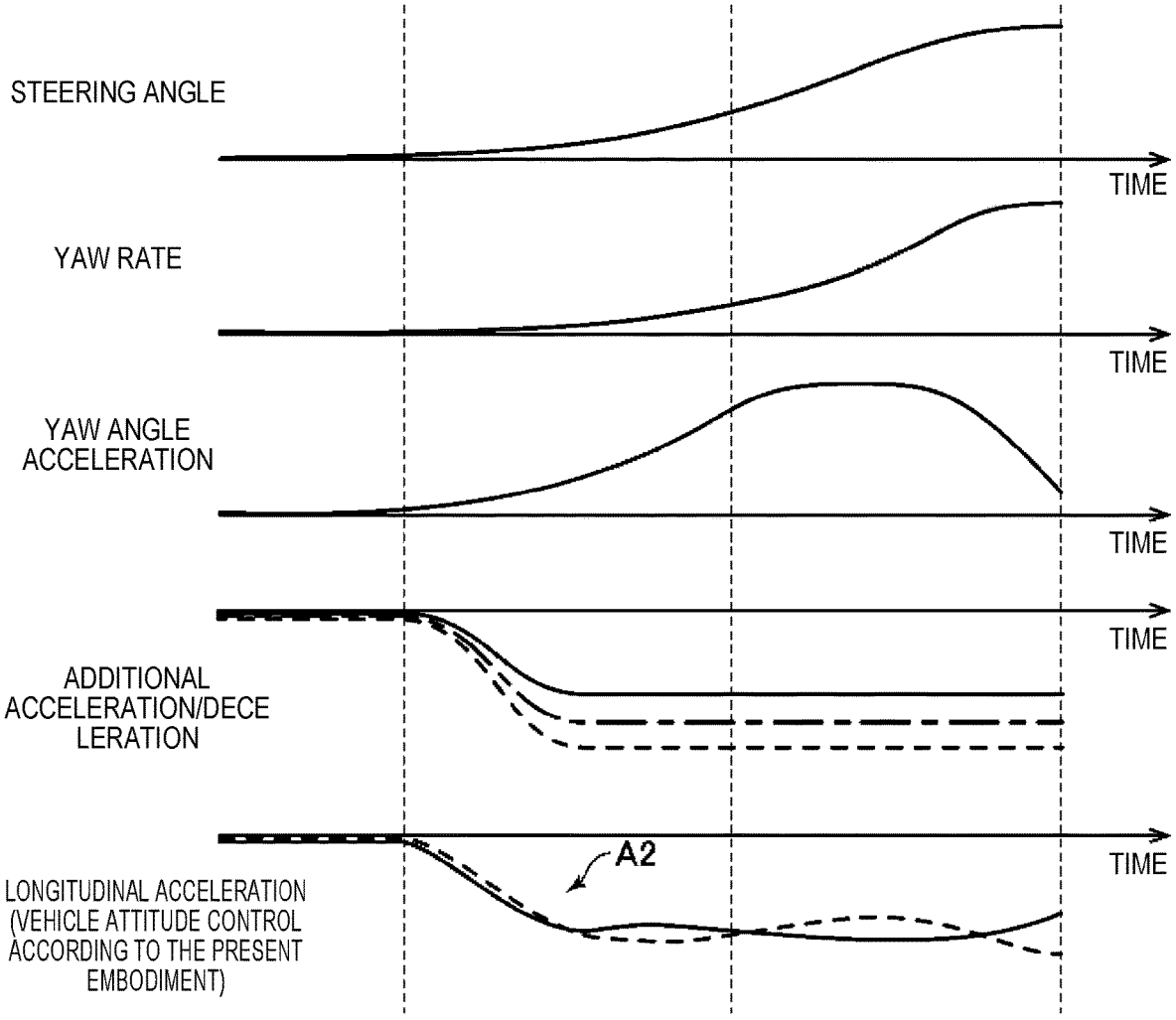

STEERING ANGLE
TIME
YAW RATE
TIME
YAW ANGLE ACCELERATION
TIME
TIME
ADDITIONAL ACCELERATION/DECELERATION
A2
TIME
LONGITUDINAL ACCELERATION (VEHICLE ATTITUDE CONTROL ACCORDING TO THE PRESENT EMBODIMENT)

FIG. 14

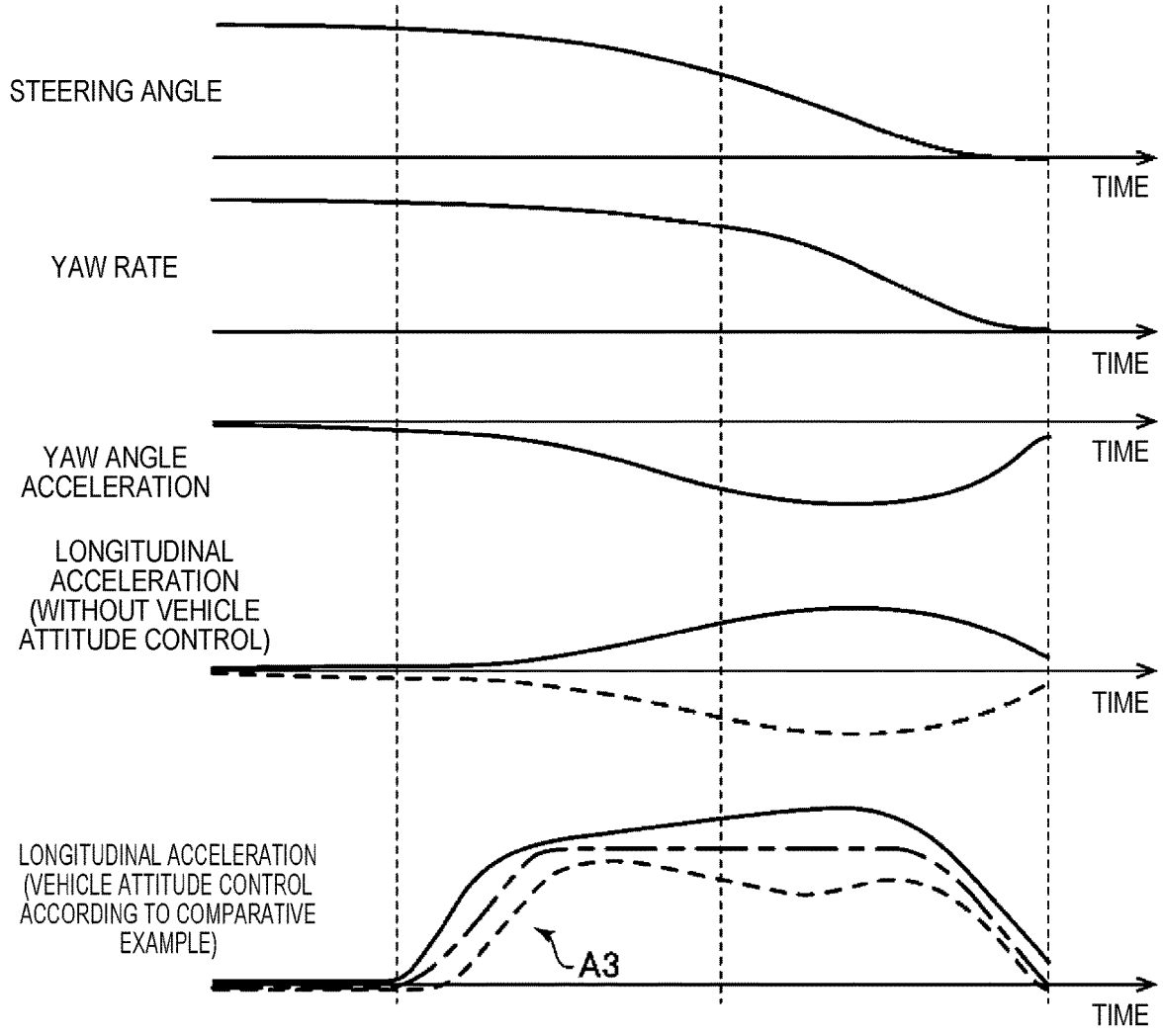

STEERING ANGLE
TIME
YAW RATE
TIME
YAW ANGLE ACCELERATION
TIME
LONGITUDINAL ACCELERATION (WITHOUT VEHICLE ATTITUDE CONTROL)
TIME
LONGITUDINAL ACCELERATION (VEHICLE ATTITUDE CONTROL ACCORDING TO COMPARATIVE EXAMPLE)
A3
TIME

FIG. 15

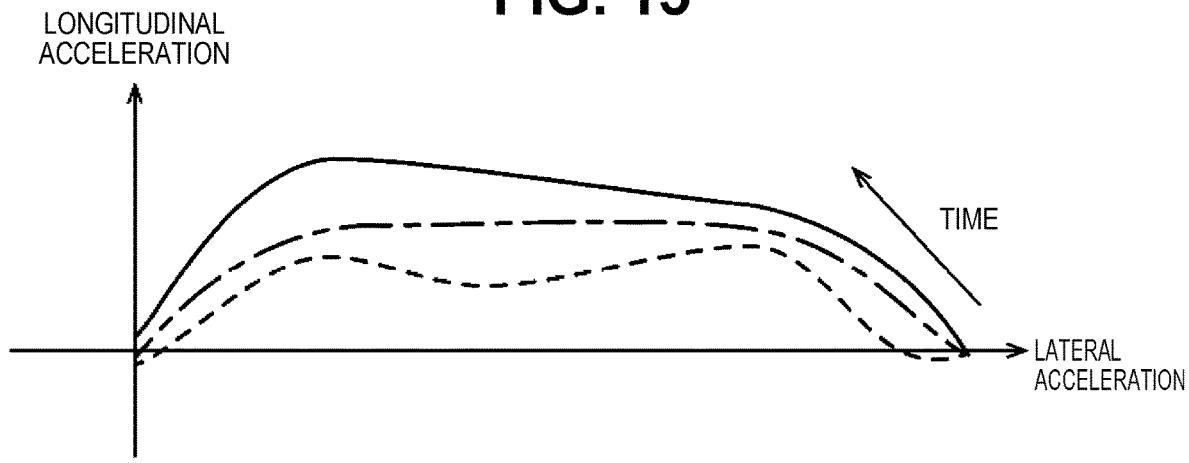
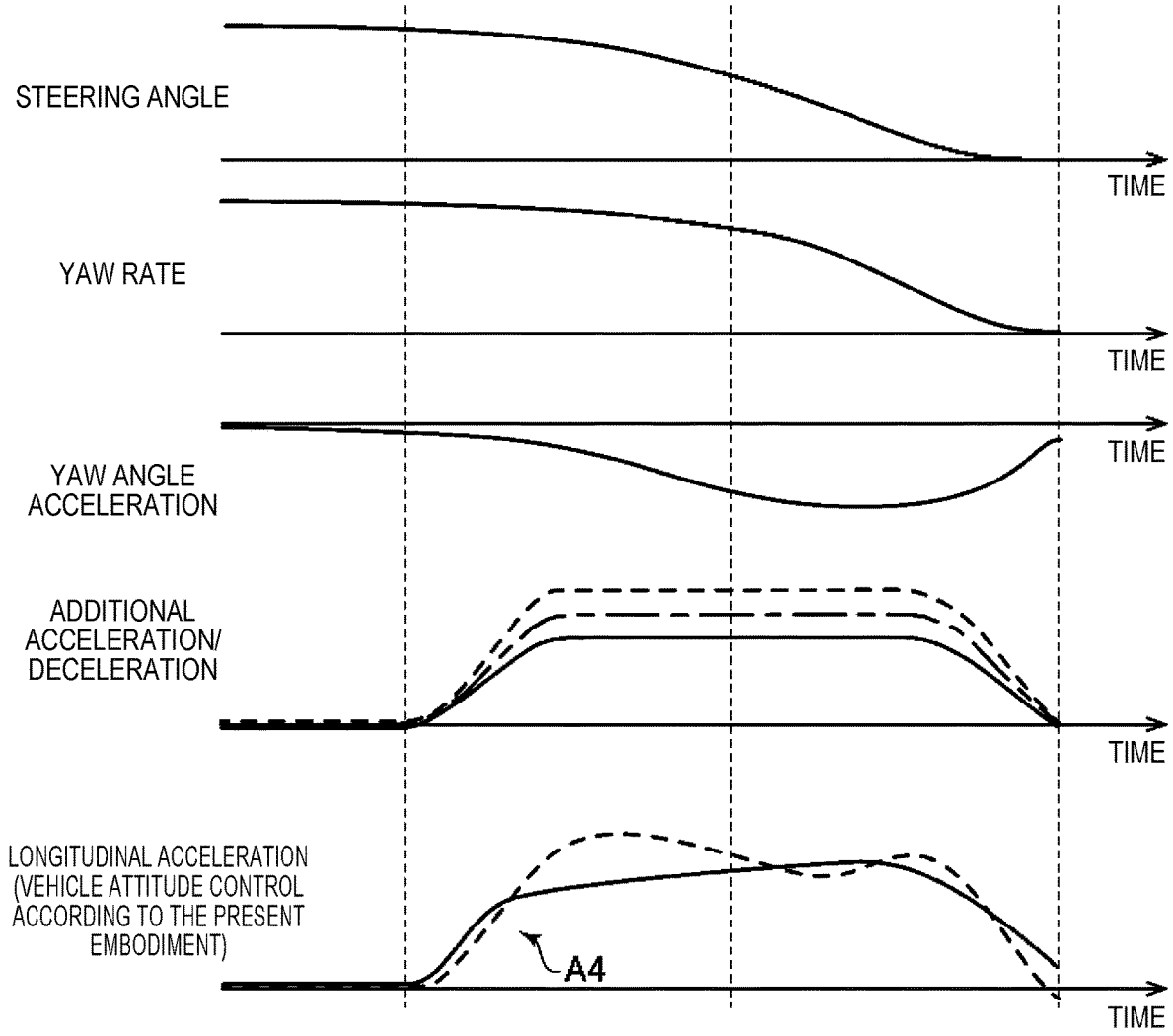

LONGITUDINAL ACCELERATION
TIME
LATERAL ACCELERATION

FIG. 16


STEERING ANGLE
TIME
YAW RATE
TIME
TIME
YAW ANGLE ACCELERATION
ADDITIONAL ACCELERATION/ DECELERATION
TIME
LONGITUDINAL ACCELERATION (VEHICLE ATTITUDE CONTROL ACCORDING TO THE PRESENT EMBODIMENT)
A4
TIME

VEHICLE CONTROL METHOD, VEHICLE SYSTEM, AND VEHICLE CONTROL APPARATUS

TECHNICAL FIELD

The present invention relates to a vehicle control method, a vehicle system, and a vehicle control apparatus which control a vehicle posture according to steering.

BACKGROUND ART

A technique has been conventionally known in which, when vehicle behavior becomes unstable due to a slip or the like, the vehicle behavior is controlled in a safe direction (for example, electronic stability control). Specifically, there has been known a technique of detecting the occurrence of understeer or oversteer behavior in the vehicle during, for example, cornering of the vehicle, and giving an appropriate deceleration to wheels so as to suppress such behavior.

On the other hand, apart from the control for improving safety in a traveling state causing the vehicle behavior to become unstable, there has been known a technique of changing torque during the operation of a steering wheel (hereinafter also referred to simply as "steering") to thereby control the vehicle behavior so that the driver's operation during cornering becomes natural and stable (see, for example, Patent Literature 1). Hereinafter, controlling a vehicle posture according to the driver's steering operation as described above will be referred to as "vehicle posture control" as appropriate.

CITATION LIST

Patent Literature

Patent Literature 1: Japanese Patent No. 5143103

SUMMARY OF INVENTION

Technical Problem

Meanwhile, the inventor of the present invention has found that a difference occurs in the longitudinal acceleration generated in the driver seat by the vehicle posture control, according to the vehicle-width-direction mounting position of the driver seat (in other words, the vehicle-width-direction mounting position of the steering) and the turning direction of the vehicle (in other words, the operation direction of the steering). In particular, it has been found that a difference occurs in rising of the longitudinal acceleration in the driver seat by the vehicle posture control (that is, the longitudinal acceleration which the driver feels), according to whether the vehicle is a right-hand drive vehicle or a left-hand drive vehicle and whether the vehicle turns right or left.

Here, the vehicle posture control is assumed to have a configuration of adding acceleration to the vehicle during a returning operation of the steering to thereby control the vehicle posture. In this configuration, when the returning operation of the steering is performed in the left turning direction (that is, during returning in the straight direction from a right turning state), rising of the longitudinal acceleration generated in the driver seat by the vehicle posture control tends to be delayed in the left-hand drive vehicle compared with in the right-hand drive vehicle. This is because when the vehicle turns left, the longitudinal acceleration generated in the driver seat during the turning becomes smaller in the left-hand drive vehicle than in the right-hand drive vehicle (typically, deceleration is generated in the left-hand drive vehicle, while acceleration is generated in the right-hand drive vehicle), and thus the longitudinal acceleration in the driver seat when acceleration by the vehicle posture control is applied to such longitudinal acceleration becomes smaller in the left-hand drive vehicle than in the right-hand drive vehicle.

On the other hand, when the returning operation of the steering is performed in the right turning direction (that is, during returning in the straight direction from a left turning state), rising of the longitudinal acceleration generated in the driver seat by the vehicle posture control tends to be delayed in the right-hand drive vehicle compared with in the left-hand drive vehicle. This is because when the vehicle turns right, the longitudinal acceleration generated in the driver seat during the turning becomes smaller in the right-hand drive vehicle than in the left-hand drive vehicle (typically, deceleration is generated in the right-hand drive vehicle, while acceleration is generated in the left-hand drive vehicle), and thus the longitudinal acceleration in the driver seat when acceleration by the vehicle posture control is applied to such longitudinal acceleration becomes smaller in the right-hand drive vehicle than in the left-hand drive vehicle.

Normally, according to the vehicle posture control, an appropriate acceleration or deceleration is added to the vehicle during the steering operation, thereby improving manipulation stability, vehicle responsiveness, and linear feeling with respect to the steering operation. Furthermore, according to such vehicle posture control, an effect of reducing driver's driving fatigue can also be obtained. Specifically, a desired longitudinal acceleration is generated by the vehicle posture control during turning, so that the driver can appropriately prepare for the lateral acceleration that changes due to the turning, that is, the driver can take an appropriate posture with respect to the lateral acceleration in advance, thus reducing driver fatigue.

However, as described above, when a difference occurs in the longitudinal acceleration generated in the driver seat during the vehicle posture control, the driver fatigue reduction effect of the vehicle posture control cannot be secured appropriately. That is, a difference occurs in rising of the longitudinal acceleration generated in the driver seat during the vehicle posture control, in particular, rising of the longitudinal acceleration is delayed, according to the vehicle-width-direction mounting position of the steering wheel (that is, whether the vehicle is a right-hand drive vehicle or a left-hand drive vehicle) and the operation direction of the steering wheel (that is, whether the vehicle turns right or left), so that driver fatigue cannot be appropriately reduced by the vehicle posture control.

The present invention has been made to solve the above-described problem and has an object to provide a vehicle control method, a vehicle system, and a vehicle control apparatus which are capable of, by performing vehicle posture control in consideration of a vehicle-width-direction mounting position of a steering wheel and an operation direction of the steering wheel, appropriately securing a driver fatigue reduction effect of the vehicle posture control.

Solution to Problem

To achieve the above-described object, the present invention is a method for controlling a vehicle in which a front wheel is driven by a prime mover (vehicle control method),

which is characterized by including a basic torque setting step of setting basic torque to be generated by the prime mover, based on an operational state of the vehicle; an acceleration torque setting step of setting acceleration torque, based on a reduction in steering angle of a steering apparatus mounted on the vehicle; a torque generation step of controlling the prime mover so that torque based on the basic torque and the acceleration torque is generated; and an acceleration torque changing step of changing the acceleration torque, based on a vehicle-width-direction mounting position of a steering wheel of the steering apparatus and an operation direction of the steering wheel when the steering angle is reduced.

In the present invention configured as above, when the steering angle of the steering apparatus is reduced, that is, the steering wheel is operated to be returned, the acceleration torque for accelerating the vehicle is added, so that the vehicle posture is controlled. In addition, in the present invention, the acceleration torque by the vehicle posture control is changed according to the vehicle-width-direction mounting position of the steering (specifically, whether the vehicle is a right-hand drive vehicle or a left-hand drive vehicle) and the operation direction of the steering when the steering angle is reduced (in other words, whether the vehicle turns right or left).

Thus, rising of the longitudinal acceleration in the driver seat by the vehicle posture control can be made almost constant irrespective of the mounting position and operation direction of the steering. That is, according to the present invention, a delay of rising of the longitudinal acceleration in the driver seat by the vehicle posture control can be resolved appropriately. From the above, according to the present invention, when the steering angle is reduced, linkage (balance) between the longitudinal acceleration and the lateral acceleration which are generated by the vehicle posture control can be secured, and a driver fatigue reduction effect of the vehicle posture control can be secured appropriately.

In the present invention, preferably, the vehicle is a right-hand drive vehicle in which the steering wheel is mounted on a right side relative to a width-direction center of the vehicle, and, in the acceleration torque changing step, when the steering angle is reduced, in a case where the steering wheel is operated in a direction of causing the vehicle to turn left, the acceleration torque is reduced compared with in a case where the steering wheel is operated in a direction of causing the vehicle to turn right.

According to the present invention configured as above, when the steering angle is reduced, the longitudinal acceleration by the vehicle posture control can be appropriately generated in the driver seat of the right-hand drive vehicle.

In the present invention, preferably, the vehicle is a left-hand drive vehicle in which the steering wheel is mounted on a left side relative to a width-direction center of the vehicle, and, in the acceleration torque changing step, when the steering angle is reduced, in a case where the steering wheel is operated in a direction of causing the vehicle to turn left, the acceleration torque is increased compared with in a case where the steering wheel is operated in a direction of causing the vehicle to turn right.

According to the present invention configured as above, when the steering angle is reduced, the longitudinal acceleration by the vehicle posture control can be appropriately generated in the driver seat of the left-hand drive vehicle.

In another aspect, to achieve the above-described object, the present invention is a method for controlling a vehicle including a braking apparatus that adds braking torque to a wheel and being in a state of being braked by this braking apparatus (vehicle control method), which is characterized by including an acceleration torque setting step of setting acceleration torque, based on a reduction in steering angle of a steering apparatus mounted on the vehicle; a torque generation step of controlling the braking apparatus so that torque based on the acceleration torque is generated; and an acceleration torque changing step of changing the acceleration torque, based on a vehicle-width-direction mounting position of a steering wheel of the steering apparatus and an operation direction of the steering wheel when the steering angle is reduced.

Furthermore, in another aspect, to achieve the above-described object, the present invention is a system for controlling a vehicle (vehicle system), which is characterized by including a prime mover that drives a front wheel of the vehicle, a steering apparatus including a steering wheel for steering the vehicle, a steering angle sensor that detects a steering angle of the steering apparatus, an operational state sensor that detects an operational state of the vehicle, and a controller that controls the prime mover, wherein the controller is configured to set basic torque to be generated by the prime mover, based on the operational state detected by the operational state sensor; set acceleration torque, based on a reduction in the steering angle detected by the steering angle sensor; control the prime mover so that torque based on the basic torque and the acceleration torque is generated; and change the acceleration torque, based on a vehicle-width-direction mounting position of the steering wheel and an operation direction of the steering wheel when the steering angle is reduced.

Furthermore, in another aspect, to achieve the above-described object, the present invention is a system for controlling a vehicle (vehicle system), which is characterized by including a braking apparatus that adds braking torque to a wheel of the vehicle, a steering apparatus including a steering wheel for steering the vehicle, a steering angle sensor that detects a steering angle of the steering apparatus, and a controller that controls the braking apparatus, wherein in a state where the vehicle is braked by the braking apparatus, the controller is configured to set acceleration torque, based on a reduction in the steering angle detected by the steering angle sensor; control the braking apparatus so that torque based on the acceleration torque is generated; and change the acceleration torque, based on a vehicle-width-direction mounting position of the steering wheel and an operation direction of the steering wheel when the steering angle is reduced.

Furthermore, in another aspect, to achieve the above-described object, the present invention is an apparatus for controlling a vehicle including a steering apparatus including a steering wheel, and configured as a right-hand drive vehicle in which this steering wheel is mounted on a right side relative to a width-direction center of the vehicle (vehicle control apparatus), which is characterized by including vehicle posture control means that adds, when a steering angle of the steering apparatus is reduced, acceleration to the vehicle to thereby control a vehicle posture; and acceleration changing means that changes the acceleration to be added by the vehicle posture control means, based on an operation direction of the steering wheel when the steering angle is reduced.

Furthermore, in another aspect, to achieve the above-described object, the present invention is an apparatus for controlling a vehicle including a steering apparatus including a steering wheel, and configured as a left-hand drive vehicle in which this steering wheel is mounted on a left side

relative to a width-direction center of the vehicle (vehicle control apparatus), which is characterized by including vehicle posture control means that adds, when a steering angle of the steering apparatus is reduced, acceleration to the vehicle to thereby control a vehicle posture; and acceleration changing means that changes the acceleration to be added by the vehicle posture control means, based on an operation direction of the steering wheel when the steering angle is reduced.

The driver fatigue reduction effect of the vehicle posture control can also be appropriately secured by the present invention according to the above-described other aspects.

Advantageous Effect of Invention

According to the vehicle control method, the vehicle system, and the vehicle control apparatus in the present invention, the vehicle posture control is performed in consideration of the vehicle-width-direction mounting position of the steering wheel and the operation direction of the steering wheel, so that the driver fatigue reduction effect of the vehicle posture control can be secured appropriately.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a block diagram schematically illustrating an overall configuration of a vehicle according to an embodiment of the present invention.

FIG. **2** is a block diagram illustrating an electrical configuration of the vehicle according to the embodiment of the present invention.

FIG. **3** is a flowchart of vehicle posture control processing according to the embodiment of the present invention.

FIG. **4** is a flowchart of deceleration torque setting processing according to the embodiment of the present invention.

FIG. **5** is a map illustrating a relationship between additional deceleration and a steering speed according to the embodiment of the present invention.

FIG. **6** is a schematic plan view of a right-hand drive vehicle and a left-hand drive vehicle.

FIG. **7** is an explanatory view of longitudinal acceleration generated in a driver seat during steering turning.

FIG. **8** is a flowchart of acceleration torque setting processing according to the embodiment of the present invention.

FIG. **9** is a map illustrating a relationship between additional acceleration and a steering speed according to the embodiment of the present invention.

FIG. **10** is an explanatory view of longitudinal acceleration generated in the driver seat during steering returning.

FIG. **11** is a time chart illustrating results in the case of performing first vehicle posture control according to a comparative example.

FIG. **12** is an explanatory view of a relationship between lateral acceleration and longitudinal acceleration in the case of performing the first vehicle posture control according to the comparative example.

FIG. **13** is a time chart illustrating results in the case of performing first vehicle posture control according to the embodiment of the present invention.

FIG. **14** is a time chart illustrating results in the case of performing second vehicle posture control according to a comparative example.

FIG. **15** is an explanatory view of a relationship between lateral acceleration and longitudinal acceleration in the case of performing the second vehicle posture control according to the comparative example.

FIG. **16** is a time chart illustrating results in the case of performing second vehicle posture control according to the embodiment of the present invention.

DESCRIPTION OF EMBODIMENT

Hereinafter, a vehicle control method, a vehicle system, and a vehicle control apparatus according to an embodiment of the present invention will be described with reference to the attached drawings.

<Configuration of Vehicle>

First, a vehicle to which the vehicle control method, the vehicle system, and the vehicle control apparatus according to the embodiment of the present invention are applied will be described with reference to FIGS. **1** and **2**. FIG. **1** is a block diagram schematically illustrating an overall configuration of the vehicle according to the embodiment of the present invention, and FIG. **2** is a block diagram illustrating an electrical configuration of the vehicle according to the embodiment of the present invention.

As illustrated in FIG. **1**, an engine **4** which is a prime mover that drives left and right front wheels **2** (drive wheels) is mounted on a vehicle body front portion of a vehicle **1**. This vehicle **1** is configured as a so-called FF vehicle. Each wheel of the vehicle **1** is suspended from the vehicle body via a suspension **30** including an elastic member (typically, a spring), a suspension arm, and the like.

The engine **4** is an internal combustion engine such as a gasoline engine or a diesel engine, and in the present embodiment, the engine **4** is a gasoline engine having a spark plug **43** (see FIG. **2**). A force is transmitted between the engine **4** and the front wheels **2** via a transmission **9**, and the engine **4** is controlled by a controller **14**. The engine **4** has a throttle valve **41** that adjusts an intake air amount, an injector **42** that injects fuel, the spark plug **43**, a variable valve operating mechanism **44** that changes opening and closing timings of intake and exhaust valves, and an engine rotation speed sensor **46** that detects a rotation speed of the engine **4** (see FIG. **2**). The engine rotation speed sensor **46** outputs a detection value thereof to the controller **14**.

Furthermore, the vehicle **1** has a steering apparatus **5** including a steering wheel **6** (hereinafter also referred to simply as "steering **6**"), a steering column **7**, and the like, a steering angle sensor **8** that detects a steering angle of the steering apparatus **5** from a rotation angle of the steering column **7**, a position of a steering rack (not illustrated), and the like, an accelerator opening sensor **10** that detects an accelerator pedal depression amount corresponding to an opening of an accelerator pedal, a brake depression amount sensor **11** that detects a depression amount of a brake pedal, a vehicle speed sensor **12** that detects a vehicle speed, and an acceleration sensor **13** that detects acceleration. The accelerator opening sensor **10**, the vehicle speed sensor **12**, and the like correspond to an operational state sensor that detects an operational state of the vehicle **1**. Each sensor outputs a detection value thereof to the controller **14**. This controller **14** is configured to include, for example, a power-train control module (PCM).

Furthermore, the vehicle **1** includes a brake control system **18** that supplies a brake fluid pressure to a brake caliper of a brake apparatus (braking apparatus) **16** provided in each wheel. The brake control system **18** includes a hydraulic pump **20** that generates a brake fluid pressure required to generate braking torque in the brake apparatus **16** provided in each wheel, a valve unit **22** (specifically, a solenoid valve) which is provided in a fluid pressure supply line to the brake apparatus **16** of each wheel and controls the fluid pressure to

be supplied from the hydraulic pump **20** to the brake apparatus **16** of each wheel, and a fluid pressure sensor **24** that detects the fluid pressure to be supplied from the hydraulic pump **20** to the brake apparatus **16** of each wheel. The fluid pressure sensor **24** is disposed, for example, at a connection portion between each valve unit **22** and the fluid pressure supply line downstream thereof, detects the fluid pressure downstream of each valve unit **22**, and outputs a detection value to the controller **14**.

The brake control system **18** calculates fluid pressures to be independently supplied to a wheel cylinder and the brake caliper in each wheel, based on a braking torque instruction value input from the controller **14** and the detection value of the fluid pressure sensor **24**, and controls a rotation speed of the hydraulic pump **20** and an opening of the valve unit **22** according to the fluid pressures.

Next, as illustrated in FIG. **2**, the controller **14** according to the present embodiment outputs control signals to control, for example, each unit of the engine **4** (for example, a turbosupercharger and an EGR apparatus other than the throttle valve **41**, the injector **42**, the spark plug **43**, and the variable valve operating mechanism **44**) and the hydraulic pump **20** and the valve unit **22** in the brake control system **18**, based on, other than detection signals of the above-described sensors **8**, **10**, **11**, **12**, and **13**, detection signals output from various sensors that detect the operational state of the vehicle **1**.

The controller **14** (which may also include the brake control system **18**) is constituted by a computer including one or more processors, various programs which are interpreted and executed on the processors (including a basic control program such as an OS and an application program that is activated on the OS to implement a specific function), and an internal memory such as a ROM or a RAM for storing the programs and various data.

The controller **14** corresponds to a "controller" in the present invention. Furthermore, a system including the engine **4**, the steering apparatus **5**, the steering angle sensor **8**, the accelerator opening sensor **10**, the vehicle speed sensor **12**, the brake apparatus **16**, and the controller **14** corresponds to the "vehicle system" in the present invention. Furthermore, the controller **14** corresponds to the "vehicle control apparatus" in the present invention and functions as "vehicle posture control means" and "acceleration changing means."

<Vehicle Posture Control>

Next, vehicle posture control according to the embodiment of the present invention will be described.

(Overall Processing)

First, an overall flow of this vehicle posture control will be described with reference to FIG. **3**. FIG. **3** is a flowchart of vehicle posture control processing according to the embodiment of the present invention.

The vehicle posture control processing of FIG. **3** is initiated when an ignition of the vehicle **1** is turned on and the power is supplied to the vehicle system, and is repeatedly executed at a predetermined cycle (for example, 50 ms).

When the vehicle posture control processing is started, as illustrated in FIG. **3**, in step S**1**, the controller **14** acquires various kinds of sensor information on the operational state of the vehicle **1**. Specifically, the controller **14** acquires, as the information on the operational state, the detection signals output by the above-described various sensors including the steering angle detected by the steering angle sensor **8**, the accelerator opening detected by the accelerator opening sensor **10**, the brake pedal depression amount detected by the brake depression amount sensor **11**, the vehicle speed detected by the vehicle speed sensor **12**, the acceleration detected by the acceleration sensor **13**, the fluid pressure detected by the fluid pressure sensor **24**, the engine rotation speed detected by the engine rotation speed sensor **46**, a gear stage currently set in the transmission **9** of the vehicle **1**, and the like.

Next, in step S**2**, the controller **14** sets target acceleration (which includes not only positive acceleration but also negative acceleration (deceleration), and the same applies to the following) based on the operational state of the vehicle **1** which is acquired in step S**1**. Specifically, when the accelerator pedal is operated, the controller **14** typically sets positive target acceleration. In this case, the controller **14** selects, from among acceleration characteristic maps (created in advance and stored in a memory or the like) each defining various vehicle speeds and various gear stages, an acceleration characteristic map corresponding to the current vehicle speed and gear stage, and refers to the selected acceleration characteristic map to set the positive target acceleration corresponding to the current accelerator opening. On the other hand, when the brake pedal is operated, the controller **14** typically sets negative target acceleration. For example, the controller **14** sets the negative target acceleration based on the brake pedal depression amount.

Next, in step S**3**, the controller **14** determines basic torque for achieving the target acceleration set in step S**2**. This basic torque includes driving torque generated by the engine **4** for driving the vehicle **1** (positive torque), and braking torque generated by the brake apparatus **16** for braking the vehicle **1** (negative torque). When the positive target acceleration is set in step S**2**, the controller **14** sets the driving torque of the engine **4** as the basic torque in principle. In this case, the controller **14** determines the basic torque within a range of torque which can be output by the engine **4**, based on the current vehicle speed, gear stage, road surface slope, road surface μ, and the like. In contrast, when the negative target acceleration (deceleration) is set in step S**2**, the controller **14** sets the braking torque generated by the brake apparatus **16** as the basic torque in principle.

Furthermore, in parallel with the processing of steps S**2** and S**3**, in step S**4**, the controller **14** executes deceleration torque setting processing in which torque for adding deceleration to the vehicle **1** (deceleration torque) is set based on a steering operation. In this step S**4**, the controller **14** sets the deceleration torque for reducing the basic torque, according to an increase in the steering angle of the steering apparatus **5**, that is, according to a turning operation of the steering **6**. In the present embodiment, when the steering **6** is operated to be turned, the controller **14** controls the vehicle posture by adding the deceleration to the vehicle **1**. Hereinafter, such vehicle posture control implemented when the steering **6** is turned will be referred to as "first vehicle posture control" as appropriate. The deceleration torque setting processing will be described later in detail.

Next, in step S**5**, the controller **14** executes acceleration torque setting processing in which torque for adding acceleration to the vehicle **1** (acceleration torque) is set based on a steering operation. In this step S**5**, the controller **14** sets the acceleration torque for increasing the basic torque, according to a reduction in the steering angle of the steering apparatus **5**, that is, according to returning of the steering **6**. In the present embodiment, when the steering **6** is operated to be returned, the controller **14** controls the vehicle posture by adding the acceleration to the vehicle **1**. Hereinafter, such vehicle posture control implemented when the steering **6** is returned will be referred to as "second vehicle posture control" as appropriate. Typically, this second vehicle pos-

ture control tends to be implemented after the above-described first vehicle posture control. The acceleration torque setting processing will be described later in detail.

After execution of the processing of steps **S2** and **S3**, the deceleration torque setting processing of step **S4**, and the acceleration torque setting processing of step **S5**, in step **S6**, the controller **14** sets final target torque based on the basic torque set in step **S3**, the deceleration torque set in step **S4**, and the acceleration torque set in step **S5**. Basically, the controller **14** calculates the final target torque by adding the acceleration torque to the basic torque or by subtracting the deceleration torque from the basic torque.

Next, in step **S7**, the controller **14** sets an actuator control amount for achieving the final target torque set in step **S6**. Specifically, the controller **14** determines various state amounts required to achieve the final target torque, based on the final target torque set in step **S6**, and sets the control amount of each actuator that drives each component of the engine **4**, based on the state amounts. In this case, the controller **14** sets a restriction value or range with respect to each state amount, and sets the control amount of each actuator to allow the state value to preserve restriction due to the restriction value or range. Subsequently, in step **S8**, the controller **14** outputs a control instruction to each actuator, based on the control amount set in step **S7**.

Specifically, in step **S8**, when the final target torque is set by subtracting the deceleration torque from the basic torque in step **S6**, that is, when the first vehicle posture control is executed, the controller **14** retards the ignition timing of the spark plug **43** compared with the ignition timing at which the basic torque is generated. Instead of or in addition to the retard of the ignition timing, the controller **14** reduces the intake air amount by reducing the throttle opening or retarding the close timing of the intake valve set after bottom dead center. In this case, the controller **14** reduces the fuel injection amount of the injector **42** according to an decrease in the intake air amount so that a predetermined air-fuel ratio is maintained.

On the other hand, when the final target torque is set by adding the acceleration torque to the basic torque in step **S6**, that is, when the second vehicle posture control is executed, the controller **14** advances the ignition timing of the spark plug **43** compared with the ignition timing at which the basic torque is generated. Instead of or in addition to the advance of the ignition timing, the controller **14** increases the intake air amount by increasing the throttle opening or advancing the close timing of the intake valve set after the bottom dead center. In this case, the controller **14** increases the fuel injection amount of the injector **42** according to the increase in the intake air amount so that a predetermined air-fuel ratio is maintained.

After step **S8** as above, the controller **14** ends the vehicle posture control processing.

(Deceleration Torque Setting Processing)

Next, the deceleration torque setting processing according to the embodiment of the present invention will be described with reference to FIGS. **4** and **5**. FIG. **4** is a flowchart of the deceleration torque setting processing according to the embodiment of the present invention, and FIG. **5** is a map illustrating a relationship between additional deceleration and a steering speed according to the embodiment of the present invention.

When the deceleration torque setting processing is started, in step **S11**, the controller **14** determines whether the steering angle (absolute value) of the steering apparatus **5** is increased (that is, whether the turning operation of the steering **6** is being performed). As a result, when the steering angle is increased (Yes in step **S11**), the controller **14** proceeds to step **S12** and determines whether the steering speed is equal to or more than a predetermined threshold S_1. That is, the controller **14** calculates the steering speed based on the steering angle acquired from the steering angle sensor **8** in step **S1** of FIG. **3** and determines whether the value is equal to or more than the threshold S_1.

As a result, when the steering speed is equal to or more than the threshold S_1 (Yes in step **S12**), the controller **14** proceeds to step **S13** and sets the additional deceleration based on the steering speed. This additional deceleration is a deceleration to be added to the vehicle **1** according to the steering operation in order to control the vehicle posture in line with the driver's intention.

Specifically, the controller **14** sets the additional deceleration corresponding to the steering speed calculated in step **S12**, based on the relationship between the additional deceleration and the steering speed which is illustrated in the map of FIG. **5**. In FIG. **5**, the horizontal axis indicates the steering speed and the vertical axis indicates the additional deceleration. As illustrated in FIG. **5**, when the steering speed is equal to or less than the threshold S_1, the corresponding additional deceleration is 0. That is, when the steering speed is equal to or less than the threshold S_1, the controller **14** does not execute the control for adding the deceleration to the vehicle **1** based on the steering operation.

On the other hand, when the steering speed exceeds the threshold S_1, the additional deceleration corresponding to this steering speed gradually approximates a predetermined upper limit value D_{max} along with the increase in the steering speed. That is, as the steering speed increases, the additional deceleration increases, and an increase rate of the increase amount decreases. This upper limit value D_{max} is set to deceleration at which the driver does not feel control intervention even when the deceleration is added to the vehicle **1** according to the steering operation (for example, 0.5 $m/s^2 \approx 0.05$ G). Furthermore, when the steering speed is equal to or more than a threshold S_2 larger than the threshold S_1, the additional deceleration is maintained at the upper limit value D_{max}.

Next, in step **S14**, the controller **14** changes the additional deceleration set in step **S13**, according to the vehicle-width-direction mounting position of the steering **6** (that is, whether the vehicle **1** is a right-hand drive vehicle or a left-hand drive vehicle) and the operation direction of the steering **6** when the steering angle is increased (that is, whether the vehicle **1** turns right or left). Here, the reason why the additional deceleration is thus changed will be described with reference to FIGS. **6** and **7**.

FIG. **6** is a schematic plan view of a right-hand drive vehicle and a left-hand drive vehicle. In chart (a) of FIG. **6**, the vehicle denoted by reference character **1***a* is the right-hand drive vehicle in which the steering **6** and a driver seat DS are mounted on the right side relative to the vehicle-width-direction center (corresponding to a center-of-gravity position G). On the other hand, in chart (b) of FIG. **6**, the vehicle denoted by reference character **1***b* is the left-hand drive vehicle in which the steering **6** and a driver seat DS are mounted on the left side relative to the vehicle-width-direction center (corresponding to a center-of-gravity position G).

FIG. **7** illustrates an example of longitudinal acceleration generated in the driver seat DS when the steering **6** is turned. Chart (a) of FIG. **7** illustrates longitudinal acceleration (solid line) generated in the driver seat DS of the left-hand drive vehicle and longitudinal acceleration (broken line) generated in the driver seat DS of the right-hand drive vehicle,

during steering turning in the left turning direction. Chart (b) of FIG. **7** illustrates longitudinal acceleration (solid line) generated in the driver seat DS of the left-hand drive vehicle and longitudinal acceleration (broken line) generated in the driver seat DS of the right-hand drive vehicle, during steering turning in the right turning direction.

As illustrated in charts (a) and (b) of FIG. **7**, the longitudinal acceleration generated in the driver seat DS changes according to whether the vehicle **1** is a right-hand drive vehicle or a left-hand drive vehicle and whether the vehicle **1** turns right or left. Specifically, as illustrated in chart (a) of FIG. **7**, when the vehicle **1** turns left, the longitudinal acceleration generated in the driver seat DS during the turning becomes larger in the right-hand drive vehicle than in the left-hand drive vehicle. Specifically, acceleration is generated in the right-hand drive vehicle, while deceleration is generated in the left-hand drive vehicle. In contrast, as illustrated in chart (b) of FIG. **7**, when the vehicle **1** turns right, the longitudinal acceleration generated in the driver seat DS during the turning becomes larger in the left-hand drive vehicle than in the right-hand drive vehicle. Specifically, acceleration is generated in the left-hand drive vehicle, while deceleration is generated in the right-hand drive vehicle.

Accordingly, when the vehicle posture control in which the deceleration is added when the steering **6** is turned (first vehicle posture control) is executed, a difference occurs in rising of the longitudinal acceleration generated in the driver seat DS by this first vehicle posture control, according to whether the vehicle **1** is a right-hand drive vehicle or a left-hand drive vehicle and whether the vehicle **1** turns right or left. Specifically, when the vehicle **1** turns left, the longitudinal acceleration in the driver seat DS becomes larger in the right-hand drive vehicle than in the left-hand drive vehicle (see chart (a) of FIG. **7**), and thus, when the additional deceleration by the first vehicle posture control is applied to this longitudinal acceleration, rising of the longitudinal acceleration in the driver seat DS by the control tends to be delayed in the right-hand drive vehicle compared with in the left-hand drive vehicle. On the other hand, when the vehicle **1** turns right, the longitudinal acceleration in the driver seat DS becomes larger in the left-hand drive vehicle than in the right-hand drive vehicle (see chart (b) of FIG. **7**), and thus, when the additional deceleration by the first vehicle posture control is applied to this longitudinal acceleration, rising of the longitudinal acceleration in the driver seat DS by the control tends to be delayed in the left-hand drive vehicle compared with in the right-hand drive vehicle.

In the present embodiment, in order to suppress such a delay of rising of the longitudinal acceleration generated in the driver seat DS by the first vehicle posture control, the additional deceleration set based on the steering speed (step S**13** of FIG. **4** and FIG. **5**) is changed according to the vehicle-width-direction mounting position of the steering **6** and the operation direction of the steering **6** when the steering angle is increased. That is, the additional deceleration set based on the steering speed is changed so that the longitudinal acceleration generated in the driver seat DS by the first vehicle posture control similarly rises irrespective of the mounting position and operation direction of the steering **6**.

Specifically, when the vehicle **1** turns left, the controller **14** increases the additional deceleration (absolute value) in the right-hand drive vehicle compared with in the left-hand drive vehicle. For example, in the right-hand drive vehicle, the controller **14** uses, as a new additional deceleration, a value obtained by multiplying a predetermined gain larger than 1 by the additional deceleration set based on the steering speed, and in the left-hand drive vehicle, the controller **14** uses, as a new additional deceleration, a value obtained by multiplying a predetermined gain less than 1 by the additional deceleration set based on the steering speed. On the other hand, when the vehicle **1** turns right, the controller **14** increases the additional deceleration (absolute value) in the left-hand drive vehicle compared with in the right-hand drive vehicle. For example, in the left-hand drive vehicle, the controller **14** uses, as a new additional deceleration, a value obtained by multiplying a predetermined gain larger than 1 by the additional deceleration set based on the steering speed, and in the right-hand drive vehicle, the controller **14** uses, as a new additional deceleration, a value obtained by multiplying a predetermined gain less than 1 (fixed value) by the additional deceleration set based on the steering speed.

These gains are determined in advance and stored in the memory in the vehicle **1**. Specifically, the gain is determined from a prior experiment, simulation, or the like so that the longitudinal acceleration generated in the driver seat DS by the first vehicle posture control becomes constant irrespective of the vehicle-width-direction mounting position of the steering **6** and the operation direction of the steering **6**. In one example, a fixed value is applied to the gain.

Note that the information on the vehicle-width-direction mounting position of the steering **6**, that is, the information indicating whether the vehicle **1** is a right-hand drive vehicle or a left-hand drive vehicle, is stored in the memory in the vehicle **1** in advance (for example, during production), and the controller **14** changes the additional deceleration based on the information stored in the memory in such a manner. Since the mounting position of the steering **6** is fixed (in other words, the vehicle **1** does not change between a right-hand drive vehicle and a left-hand drive vehicle), after all, in the actual control, the controller **14** does not perform the processing in which the additional deceleration is changed as appropriate according to the mounting position of the steering **6**, but changes the additional deceleration according to only the operation direction of the steering **6**.

Returning to FIG. **4**, the controller **14** proceeds to step S**15** after the above-described step S**14**. In step S**15**, the controller **14** sets the deceleration torque based on the additional deceleration changed in step S**14**. Specifically, the controller **14** determines the deceleration torque required to reduce the basic torque so as to achieve the additional deceleration, based on the current vehicle speed, gear stage, road surface slope, and the like which are acquired in step S**1** of FIG. **3**. After step S**15**, the controller **14** ends the deceleration torque setting processing and returns to the main routine.

Alternatively, when the steering angle is not increased in step S**11** (No in step S**11**) or when the steering speed is less than the threshold S_1 in step S**12** (No in step S**12**), the controller **14** ends the deceleration torque setting processing without setting the deceleration torque and returns to the main routine of FIG. **3**. In this case, the deceleration torque becomes 0.

(Acceleration Torque Setting Processing)

Next, the acceleration torque setting processing according to the embodiment of the present invention will be described with reference to FIGS. **8** and **9**. FIG. **8** is a flowchart of the acceleration torque setting processing according to the embodiment of the present invention, and FIG. **9** is a map illustrating a relationship between additional acceleration and a steering speed according to the embodiment of the present invention.

When the acceleration torque setting processing is started, in step S21, the controller **14** determines whether the steering angle (absolute value) of the steering apparatus **5** is reduced (that is, whether the returning operation of the steering **6** is being performed). As a result, when the steering angle is reducing (Yes in step S21), the controller **14** proceeds to step S22 and determines whether the steering speed is equal to or more than the predetermined threshold S_1. That is, the controller **14** calculates the steering speed based on the steering angle acquired from the steering angle sensor **8** in step S1 of FIG. **3** and determines whether the value is equal to or more than the threshold S_1.

As a result, when the steering speed is equal to or more than the threshold S_1 (Yes in step S22), the controller **14** proceeds to step S23 and sets the additional acceleration based on the steering speed. This additional acceleration is an acceleration to be added to the vehicle **1** according to the steering operation in order to control the vehicle posture in line with the driver's intention.

Specifically, the controller **14** sets the additional acceleration corresponding to the steering speed calculated in step S22, based on the relationship between the additional acceleration and the steering speed which is illustrated in the map of FIG. **9**. In FIG. **9**, the horizontal axis indicates the steering speed and the vertical axis indicates the additional acceleration. As illustrated in FIG. **9**, when the steering speed is equal to or less than the threshold S_1, the corresponding additional acceleration is 0. That is, when the steering speed is equal to or less than the threshold S_1, the controller **14** does not execute the control for adding the acceleration to the vehicle **1** based on the steering operation.

On the other hand, when the steering speed exceeds the threshold S_1, the additional acceleration corresponding to this steering speed gradually approximates a predetermined upper limit value A_{max} along with the increase in the steering speed. That is, as the steering speed increases, the additional acceleration increases, and an increase rate of the increase amount decreases. This upper limit value A_{max} is set to acceleration at which the driver does not feel control intervention even when the acceleration is added to the vehicle **1** according to the steering operation (for example, 0.5 $m/s^2 \approx 0.05$ G). Furthermore, when the steering speed is equal to or more than the threshold S_2 larger than the threshold S_1, the additional acceleration is maintained at the upper limit value A_{max}.

Next, in step S24, the controller **14** changes the additional acceleration set in step S23, according to the vehicle-width-direction mounting position of the steering **6** (that is, whether the vehicle **1** is a right-hand drive vehicle or a left-hand drive vehicle) and the operation direction of the steering **6** when the steering angle is reduced (that is, whether the vehicle **1** turns right or left). Here, the reason why the additional acceleration is thus changed will be described with reference to FIG. **10**.

FIG. **10** illustrates an example of longitudinal acceleration generated in the driver seat DS when the steering **6** is returned. Chart (a) of FIG. **10** illustrates longitudinal acceleration (solid line) generated in the driver seat DS of the left-hand drive vehicle and longitudinal acceleration (broken line) generated in the driver seat DS of the right-hand drive vehicle, during steering returning in the left turning direction. Chart (b) of FIG. **10** illustrates longitudinal acceleration (solid line) generated in the driver seat DS of the left-hand drive vehicle and longitudinal acceleration (broken line) generated in the driver seat DS of the right-hand drive vehicle, during steering returning in the right turning direction.

As illustrated in charts (a) and (b) FIG. **10**, the longitudinal acceleration generated in the driver seat DS changes according to whether the vehicle **1** is a right-hand drive vehicle or a left-hand drive vehicle and whether the vehicle **1** turns right or left. Specifically, as illustrated in chart (a) of FIG. **10**, during steering returning in the left turning direction, the longitudinal acceleration generated in the driver seat DS during the turning becomes smaller in the left-hand drive vehicle than in the right-hand drive vehicle. Specifically, deceleration is generated in the left-hand drive vehicle, while acceleration is generated in the right-hand drive vehicle. In contrast, as illustrated in chart (b) of FIG. **10**, during steering returning in the right turning direction, the longitudinal acceleration generated in the driver seat DS during the turning becomes smaller in the right-hand drive vehicle than in the left-hand drive vehicle. Specifically, deceleration is generated in the right-hand drive vehicle, while acceleration is generated in the left-hand drive vehicle.

Accordingly, when the vehicle posture control in which the acceleration is added when the steering **6** is returned (second vehicle posture control) is executed, a difference occurs in rising of the longitudinal acceleration generated in the driver seat DS by this second vehicle posture control, according to whether the vehicle **1** is a right-hand drive vehicle or a left-hand drive vehicle and whether the vehicle **1** turns right or left. Specifically, when the steering **6** is returned in the left turning direction (that is, the vehicle **1** turns left), the longitudinal acceleration in the driver seat DS becomes smaller in the left-hand drive vehicle than in the right-hand drive vehicle (see chart (a) of FIG. **10**), and thus, when the additional acceleration by the second vehicle posture control is applied to this longitudinal acceleration, rising of the longitudinal acceleration in the driver seat DS by the control tends to be delayed in the left-hand drive vehicle compared with in the right-hand drive vehicle. On the other hand, when the steering **6** is returned in the right turning direction (that is, the vehicle **1** turns right), the longitudinal acceleration in the driver seat DS becomes smaller in the right-hand drive vehicle than in the left-hand drive vehicle (see chart (b) of FIG. **10**), and thus, when the additional acceleration by the second vehicle posture control is applied to this longitudinal acceleration, rising of the longitudinal acceleration in the driver seat DS by the control tends to be delayed in the right-hand drive vehicle compared with in the left-hand drive vehicle.

In the present embodiment, in order to suppress such a delay of rising of the longitudinal acceleration generated in the driver seat DS by the second vehicle posture control, the additional acceleration set based on the steering speed (step S23 of FIG. **8** and FIG. **9**) is changed according to the vehicle-width-direction mounting position of the steering **6** and the operation direction of the steering **6** when the steering angle is reduced. That is, the additional acceleration set based on the steering speed is changed so that the longitudinal acceleration generated in the driver seat DS by the second vehicle posture control similarly rises irrespective of the mounting position and operation direction of the steering **6**.

Specifically, when the steering **6** is returned in the left turning direction (that is, the vehicle **1** turns left), the controller **14** increases the additional acceleration in the left-hand drive vehicle compared with in the right-hand drive vehicle. For example, in the left-hand drive vehicle, the controller **14** uses, as a new additional acceleration, a value obtained by multiplying a predetermined gain larger than 1 by the additional acceleration set based on the steering speed, and in the right-hand drive vehicle, the

controller **14** uses, as a new additional acceleration, a value obtained by multiplying a predetermined gain less than 1 by the additional acceleration set based on the steering speed. On the other hand, when the steering **6** is returned in the right turning direction (that is, the vehicle **1** turns right), the controller **14** increases the additional acceleration in the right-hand drive vehicle compared with in the left-hand drive vehicle. For example, in the right-hand drive vehicle, the controller **14** uses, as a new additional acceleration, a value obtained by multiplying a predetermined gain larger than 1 by the additional acceleration set based on the steering speed, and in the left-hand drive vehicle, the controller **14** uses, as a new additional acceleration, a value obtained by multiplying a predetermined gain less than 1 (fixed value) by the additional acceleration set based on the steering speed.

These gains are determined in advance and stored in the memory in the vehicle **1**. Specifically, the gain is determined from a prior experiment, simulation, or the like so that the longitudinal acceleration generated in the driver seat DS by the second vehicle posture control becomes constant irrespective of the vehicle-width-direction mounting position of the steering **6** and the operation direction of the steering **6**. In one example, a fixed value is applied to the gain.

Note that the information on the vehicle-width-direction mounting position of the steering **6**, that is, the information indicating whether the vehicle **1** is a right-hand drive vehicle or a left-hand drive vehicle, is stored in the memory in the vehicle **1** in advance (for example, during production), and the controller **14** changes the additional acceleration based on the information stored in the memory in such a manner. Since the mounting position of the steering **6** is fixed (in other words, the vehicle **1** does not change between a right-hand drive vehicle and a left-hand drive vehicle), after all, in the actual control, the controller **14** does not perform the processing in which the additional acceleration is changed as appropriate according to the mounting position of the steering **6**, but changes the additional acceleration according to only the operation direction of the steering **6**.

Returning to FIG. **8**, the controller **14** proceeds to step S**25** after the above-described step S**24**. In step S**25**, the controller **14** sets the acceleration torque based on the additional acceleration changed in step S**24**. Specifically, the controller **14** determines the acceleration torque required to increase the basic torque so as to achieve the additional acceleration, based on the current vehicle speed, gear stage, road surface slope, and the like which are acquired in step S**1**. After step S**24**, the controller **14** ends the acceleration torque setting processing and returns to the main routine of FIG. **3**.

Alternatively, when the steering angle is not reduced in step S**21** (No in step S**21**) or when the steering speed is less than the threshold S_1 in step S**22** (No in step S**22**), the controller **14** ends the acceleration torque setting processing without setting the acceleration torque and returns to the main routine of FIG. **3**. In this case, the acceleration torque becomes 0.

<Operations and Effects>

Next, operations and effects according to the embodiment of the above-described present invention will be described.

(Operations of First Vehicle Posture Control According to the Present Embodiment)

First, operations of the first vehicle posture control according to the embodiment of the present invention will be described. Here, operations of the present embodiment will be specifically described with reference to a comparative example with respect to the present embodiment. As described above, in the present embodiment, according to the vehicle-width-direction mounting position of the steering **6** and the operation direction of the steering **6**, the deceleration torque by the first vehicle posture control is changed, in other words, the additional deceleration is changed (see step S**14** of FIG. **4**). In contrast, in the comparative example, according to the mounting position and operation direction of the steering **6**, the additional deceleration and the deceleration torque by the first vehicle posture control are not changed.

FIG. **11** is a time chart for describing results in the case of performing first vehicle posture control according to the comparative example. FIG. **11** illustrates, in order from the top, a steering angle, a yaw rate, yaw angle acceleration, longitudinal acceleration in the driver seat DS in the case of not performing the first vehicle posture control, and longitudinal acceleration in the driver seat DS in the case of performing the first vehicle posture control according to the comparative example. In FIG. **11**, the solid line indicates the results in the left-hand drive vehicle, and the broken line indicates the results in the right-hand drive vehicle.

Here, a case where the steering **6** is turned in the left turning direction will be exemplified. When the steering **6** is turned in the left turning direction, as illustrated in FIG. **11**, the steering angle, the yaw rate, and the yaw angle acceleration change, and the vehicle **1** turns left. When the vehicle **1** thus turns left, as illustrated in FIG. **11**, the longitudinal acceleration in the driver seat DS becomes larger in the right-hand drive vehicle (see the broken line) than in the left-hand drive vehicle (see the solid line). Specifically, acceleration is generated in the right-hand drive vehicle, while deceleration is generated in the left-hand drive vehicle (similar to chart (a) of FIG. **7**). The longitudinal acceleration generated in the vehicle **1** during turning is determined according to the position in the vehicle **1** (specifically, the distance from the center-of-gravity position G) and the magnitude of the yaw angle acceleration. In particular, the longitudinal acceleration generated in the driver seat DS during turning can be obtained by "left-right distance from the center-of-gravity position G to the driver seat DS×yaw angle acceleration." The left-right distance from the center-of-gravity position G to the driver seat DS is defined as a positive value in the right-hand drive vehicle and defined as a negative value in the left-hand drive vehicle. Furthermore, during left turning, the yaw angle acceleration becomes a positive value. Accordingly, during steering turning in the left turning direction, positive longitudinal acceleration is generated in the right-hand drive vehicle, while negative longitudinal acceleration (deceleration) is generated in the left-hand drive vehicle.

In the comparative example, the additional deceleration as indicated by the one-dot chain line of FIG. **11** is applied to the first vehicle posture control. More specifically, in the comparative example, the additional deceleration is not changed between the right-hand drive vehicle and the left-hand drive vehicle. That is, the same additional deceleration is applied to both the right-hand drive vehicle and the left-hand drive vehicle. As a result, according to the first vehicle posture control of the comparative example, as indicated by arrow A**1** in FIG. **11**, rising of the longitudinal acceleration in the driver seat DS is delayed in the right-hand drive vehicle (see the broken line) compared with in the left-hand drive vehicle (see the solid line). That is, as described above, during left turning, the longitudinal acceleration in the driver seat DS becomes larger in the right-hand drive vehicle than in the left-hand drive vehicle, and thus, in the right and left hand drive vehicles, when the same additional deceleration is applied to this longitudinal accel-

eration by the first vehicle posture control, rising of the longitudinal acceleration in the driver seat DS by the control is delayed in the right-hand drive vehicle compared with in the left-hand drive vehicle. Note that the change in the longitudinal acceleration as indicated by arrow **A1** in FIG. **11** is, strictly speaking, "falling," but it can also be said that the longitudinal acceleration is rising in the negative direction; accordingly, such a change in the longitudinal acceleration is expressed as "rising" in the present description.

Next, FIG. **12** is an explanatory view of a relationship between lateral acceleration (horizontal axis) and longitudinal acceleration (vertical axis) in the case of performing the first vehicle posture control according to the comparative example. FIG. **12** corresponds to a view in which a portion indicated by arrow **A1** of FIG. **11** is enlarged. Accordingly, what is meant by each of the solid line, the broken line, and the one-dot chain line is the same as in FIG. **11**. As also illustrated in this FIG. **12**, rising is delayed in the longitudinal acceleration generated in the driver seat DS of the right-hand drive vehicle during left turning (see the broken line) compared with in the longitudinal acceleration generated in the driver seat DS of the left-hand drive vehicle during left turning (see the solid line). Specifically, rising of the longitudinal acceleration is delayed in the relationship with the lateral acceleration. Linkage (balance) between the longitudinal acceleration and the lateral acceleration which are generated by the first vehicle posture control is lost by such a delay of rising. As a result, according to the comparative example, a driver fatigue reduction effect of the first vehicle posture control is not secured appropriately.

Next, FIG. **13** is a time chart for describing results in the case of performing the first vehicle posture control according to the embodiment of the present invention. FIG. **13** illustrates, in order from the top, a steering angle, a yaw rate, yaw angle acceleration, additional deceleration applied by the first vehicle posture control according to the present embodiment, and longitudinal acceleration in the driver seat DS in the case of performing the first vehicle posture control according to the present embodiment. In FIG. **13**, the solid line indicates the results in the left-hand drive vehicle, and the broken line indicates the results in the right-hand drive vehicle.

Here, a case where the steering **6** is turned in the left turning direction will be exemplified. When the steering **6** is turned in the left turning direction, as illustrated in FIG. **13**, the steering angle, the yaw rate, and the yaw angle acceleration change, and the vehicle **1** turns left. In the present embodiment, in the case of performing the first vehicle posture control when the vehicle **1** thus turns left, as illustrated in FIG. **13**, the additional deceleration (absolute value) to be applied to the right-hand drive vehicle is increased compared with the additional deceleration (absolute value) to be applied to the left-hand drive vehicle. Specifically, in the right-hand drive vehicle, the controller **14** uses, as a new additional deceleration (see the broken line), a value obtained by multiplying a predetermined gain larger than 1 by the additional deceleration set based on the steering speed (see the one-dot chain line), and in the left-hand drive vehicle, the controller **14** uses, as a new additional deceleration (see the solid line), a value obtained by multiplying a predetermined gain less than 1 by the additional deceleration set based on the steering speed (see the one-dot chain line).

According to the present embodiment as described above, the larger additional deceleration (absolute value) is applied to the right-hand drive vehicle than to the left-hand drive vehicle, so that, as indicated by arrow **A2** in FIG. **13**, rising of the longitudinal acceleration in the driver seat DS by the first vehicle posture control becomes almost the same in the right-hand drive vehicle and the left-hand drive vehicle. That is, according to the present embodiment, the delay of rising of the longitudinal acceleration as described in the comparative example (see FIG. **11**) can be resolved appropriately. Thus, linkage (balance) between the longitudinal acceleration and the lateral acceleration which are generated by the first vehicle posture control can be secured. Therefore, according to the present embodiment, the driver fatigue reduction effect of the first vehicle posture control can be secured appropriately.

Although in FIGS. **11** to **13**, the case of performing the first vehicle posture control when the steering **6** is turned in the left turning direction has been exemplified, the same results can also be obtained in the case of performing the first vehicle posture control when the steering **6** is turned in the right turning direction.

(Operations of Second Vehicle Posture Control According to the Present Embodiment)

Next, operations of the second vehicle posture control according to the embodiment of the present invention will be described. Here, operations of the present embodiment will be specifically described with reference to a comparative example with respect to the present embodiment. As described above, in the present embodiment, according to the vehicle-width-direction mounting position of the steering **6** and the operation direction of the steering **6**, the acceleration torque by the second vehicle posture control is changed, in other words, the additional acceleration is changed (see step **S24** of FIG. **8**). In contrast, in the comparative example, according to the mounting position and operation direction of the steering **6**, the additional acceleration and the acceleration torque by the second vehicle posture control are not changed.

FIG. **14** is a time chart for describing results in the case of performing second vehicle posture control according to the comparative example. FIG. **14** illustrates, in order from the top, a steering angle, a yaw rate, yaw angle acceleration, longitudinal acceleration in the driver seat DS in the case of not performing the second vehicle posture control, and longitudinal acceleration in the driver seat DS in the case of performing the second vehicle posture control according to the comparative example. In FIG. **14**, the solid line indicates the results in the left-hand drive vehicle, and the broken line indicates the results in the right-hand drive vehicle.

Here, a case where the steering **6** turned in the left turning direction is returned in the right turning direction will be exemplified. When the steering **6** is returned in the right turning direction, as illustrated in FIG. **14**, the steering angle, the yaw rate, and the yaw angle acceleration change, and the vehicle **1** turns right. When the vehicle **1** thus turns right, as illustrated in FIG. **14**, the longitudinal acceleration in the driver seat DS becomes smaller in the right-hand drive vehicle (see the broken line) than in the left-hand drive vehicle (see the solid line). Specifically, deceleration is generated in the right-hand drive vehicle, while acceleration is generated in the left-hand drive vehicle (similar to chart (b) of FIG. **10**). As described above, the longitudinal acceleration generated in the driver seat DS during turning can be obtained by "left-right distance from the center-of-gravity position G to the driver seat DS×yaw angle acceleration." The left-right distance from this center-of-gravity position G to the driver seat DS is defined as a positive value in the right-hand drive vehicle and defined as a negative value in the left-hand drive vehicle. Furthermore, during right turning, the yaw angle acceleration becomes a negative value.

Accordingly, during steering returning in the right turning direction, negative longitudinal acceleration (deceleration) is generated in the right-hand drive vehicle, while positive longitudinal acceleration is generated in the left-hand drive vehicle.

In the comparative example, the additional acceleration as indicated by the one-dot chain line of FIG. **14** is applied to the second vehicle posture control. More specifically, in the comparative example, the additional acceleration is not changed between the right-hand drive vehicle and the left-hand drive vehicle. That is, the same additional acceleration is applied to both the right-hand drive vehicle and the left-hand drive vehicle. As a result, according to the second vehicle posture control of the comparative example, as indicated by arrow A**3** in FIG. **14**, rising of the longitudinal acceleration in the driver seat DS is delayed in the right-hand drive vehicle (see the broken line) compared with in the left-hand drive vehicle (see the solid line). That is, as described above, during right turning, the longitudinal acceleration in the driver seat DS becomes smaller in the right-hand drive vehicle than in the left-hand drive vehicle, and thus, in the right and left hand drive vehicles, when the same additional acceleration is applied to this longitudinal acceleration by the second vehicle posture control, rising of the longitudinal acceleration in the driver seat DS by the control is delayed in the right-hand drive vehicle compared with in the left-hand drive vehicle.

Next, FIG. **15** is an explanatory view of a relationship between lateral acceleration (horizontal axis) and longitudinal acceleration (vertical axis) in the case of performing the second vehicle posture control according to the comparative example. FIG. **15** corresponds to the lowermost view of FIG. **14**. Accordingly, what is meant by each of the solid line, the broken line, and the one-dot chain line is the same as in FIG. **14**. As also illustrated in this FIG. **15**, rising is delayed in the longitudinal acceleration generated in the driver seat DS of the right-hand drive vehicle during right turning (see the broken line) compared with in the longitudinal acceleration generated in the driver seat DS of the left-hand drive vehicle during right turning (see the solid line). Specifically, rising of the longitudinal acceleration is delayed in the relationship with the lateral acceleration. Linkage (balance) between the longitudinal acceleration and the lateral acceleration which are generated by the second vehicle posture control is lost by such a delay of rising. As a result, according to the comparative example, a driver fatigue reduction effect of the second vehicle posture control is not secured appropriately.

Next, FIG. **16** is a time chart for describing results in the case of performing the second vehicle posture control according to the embodiment of the present invention. FIG. **16** illustrates, in order from the top, a steering angle, a yaw rate, yaw angle acceleration, additional acceleration applied by the second vehicle posture control according to the present embodiment, and longitudinal acceleration in the driver seat DS in the case of performing the second vehicle posture control according to the present embodiment. In FIG. **16**, the solid line indicates the results in the left-hand drive vehicle, and the broken line indicates the results in the right-hand drive vehicle.

Here, a case where the steering **6** turned in the left turning direction is returned in the right turning direction will be exemplified. When the steering **6** is returned in the right turning direction, as illustrated in FIG. **16**, the steering angle, the yaw rate, and the yaw angle acceleration change, and the vehicle **1** turns right. In the present embodiment, in the case of performing the second vehicle posture control when the vehicle **1** thus turns right, as illustrated in FIG. **16**, the additional acceleration to be applied to the right-hand drive vehicle is increased compared with the additional acceleration to be applied to the left-hand drive vehicle. Specifically, in the right-hand drive vehicle, the controller **14** uses, as a new additional acceleration (see the broken line), a value obtained by multiplying a predetermined gain larger than 1 by the additional acceleration set based on the steering speed (see the one-dot chain line), and in the left-hand drive vehicle, the controller **14** uses, as a new additional acceleration (see the solid line), a value obtained by multiplying a predetermined gain less than 1 by the additional acceleration set based on the steering speed (see the one-dot chain line).

According to the present embodiment as described above, the larger additional acceleration is applied to the right-hand drive vehicle than to the left-hand drive vehicle, so that, as indicated by arrow A**4** in FIG. **16**, rising of the longitudinal acceleration in the driver seat DS by the second vehicle posture control becomes almost the same in the right-hand drive vehicle and the left-hand drive vehicle. That is, according to the present embodiment, the delay of rising of the longitudinal acceleration as described in the comparative example (see FIG. **14**) can be resolved appropriately. Thus, linkage (balance) between the longitudinal acceleration and the lateral acceleration which are generated by the second vehicle posture control can be secured. Therefore, according to the present embodiment, the driver fatigue reduction effect of the second vehicle posture control can be secured appropriately.

Although in FIGS. **14** to **16**, the case of performing the second vehicle posture control when the steering **6** is returned in the right turning direction has been exemplified, the same results can also be obtained in the case of performing the second vehicle posture control when the steering **6** is returned in the left turning direction.

Effects of the Present Embodiment

As described above, in the present embodiment, in the case of performing the first vehicle posture control in which the deceleration torque is added according to the increase in the steering angle (that is, the turning operation of the steering **6**), the deceleration torque by the first vehicle posture control is changed based on the vehicle-width-direction mounting position of the steering **6** and the operation direction of the steering **6** when the steering angle is increased. Thus, rising of the longitudinal acceleration in the driver seat DS by the first vehicle posture control can be made almost constant irrespective of the mounting position and operation direction of the steering **6**. That is, according to the present embodiment, the delay of rising of the longitudinal acceleration in the driver seat DS by the first vehicle posture control can be resolved appropriately. Accordingly, according to the present embodiment, linkage (balance) between the longitudinal acceleration and the lateral acceleration which are generated by the first vehicle posture control can be secured, and the driver fatigue reduction effect of the first vehicle posture control can be secured appropriately.

More specifically, in the present embodiment, when the vehicle **1** is the right-hand drive vehicle, during the increase in the steering angle, in the case where the steering **6** is operated in the left turning direction, the deceleration torque is increased compared with in the case where the steering **6** is operated in the right turning direction, so that the longi-

tudinal acceleration by the first vehicle posture control can be appropriately generated in the driver seat DS of the right-hand drive vehicle.

Alternatively, in the present embodiment, when the vehicle **1** is the left-hand drive vehicle, during the increase in the steering angle, in the case where the steering **6** is operated in the left turning direction, the deceleration torque is reduced compared with in the case where the steering **6** is operated in the right turning direction, so that the longitudinal acceleration by the first vehicle posture control can be appropriately generated in the driver seat DS of the left-hand drive vehicle.

Furthermore, in the present embodiment, in the case of performing the second vehicle posture control in which the acceleration torque is added according to the reduction in the steering angle (that is, the returning operation of the steering **6**), the acceleration torque by the second vehicle posture control is changed based on the vehicle-width-direction mounting position of the steering **6** and the operation direction of the steering **6** when the steering angle is reduced. Thus, rising of the longitudinal acceleration in the driver seat DS by the second vehicle posture control can be made almost constant irrespective of the mounting position and operation direction of the steering **6**. That is, according to the present embodiment, the delay of rising of the longitudinal acceleration in the driver seat DS by the second vehicle posture control can be resolved appropriately. Accordingly, according to the present embodiment, linkage (balance) between the longitudinal acceleration and the lateral acceleration which are generated by the second vehicle posture control can be secured, and the driver fatigue reduction effect of the second vehicle posture control can be secured appropriately.

More specifically, in the present embodiment, when the vehicle **1** is the right-hand drive vehicle, during the reduction in the steering angle, in the case where the steering **6** is operated in the left turning direction, the acceleration torque is reduced compared with in the case where the steering **6** is operated in the right turning direction, so that the longitudinal acceleration by the second vehicle posture control can be appropriately generated in the driver seat DS of the right-hand drive vehicle.

Alternatively, in the present embodiment, when the vehicle **1** is the left-hand drive vehicle, during the reduction in the steering angle, in the case where the steering **6** is operated in the left turning direction, the acceleration torque is increased compared with in the case where the steering **6** is operated in the right turning direction, so that the longitudinal acceleration by the second vehicle posture control can be appropriately generated in the driver seat DS of the left-hand drive vehicle.

<Modifications>

Hereinafter, a modification of the above-described embodiment will be described.

(Modification 1)

Although in the above-described embodiment, the case where the engine **4** is a gasoline engine has been described, in another example, the present invention is also applicable to a diesel engine (the engine does not have the spark plug **43** and the like). In this example, when the final target torque is set by subtracting the deceleration torque from the basic torque in step S**6** of FIG. **3**, that is, when the first vehicle posture control is performed, the controller **14** may reduce the fuel injection amount of the injector of the diesel engine compared with the fuel injection amount for generating the basic torque. In contrast, when the final target torque is set by adding the acceleration torque to the basic torque in step S**6**, that is, when the second vehicle posture control is performed, the controller **14** may increase the fuel injection amount of the injector compared with the fuel injection amount for generating the basic torque.

Furthermore, in another example, the present invention is also applicable to the vehicle **1** having a motor generator. That is, the motor generator (which may be simply a motor (electric motor)) may be used as a prime mover. In this example, instead of or in addition to the control of the engine **4** as described above, the motor generator may be controlled so as to achieve the final target torque set in step S**6** of FIG. **3**. Specifically, in the case of performing the first vehicle posture control in which the deceleration torque is added to the vehicle **1**, the controller **14** may reduce the torque to be generated by the motor generator. In contrast, in the case of performing the second vehicle posture control in which the acceleration torque is added to the vehicle **1**, the controller **14** may increase the torque to be generated by the motor generator.

Furthermore, in another example, in the case of performing the first vehicle posture control, the controller **14** may control the brake apparatus **16** so that the braking torque corresponding to the deceleration torque is added to the vehicle **1**. Alternatively, the controller **14** may cause the motor generator to perform regenerative power generation so that the regenerative torque (which becomes the braking torque) generated by the motor generator is added to the vehicle **1**.

Furthermore, in another example, in the case of performing the second vehicle posture control, when the vehicle **1** is braked by the brake apparatus **16**, the controller **14** may control the brake apparatus **16** so that the braking torque to be added to the vehicle **1** is reduced, to thereby achieve the acceleration torque by the second vehicle posture control. In addition, in the case of performing the second vehicle posture control, when the vehicle **1** is braked by the regenerative torque of the motor generator, the controller **14** may control the motor generator so that the regenerative torque to be added to the vehicle **1** is reduced, to thereby achieve the acceleration torque by the second vehicle posture control.

(Modification 2)

In the above-described embodiment, the additional deceleration and the additional acceleration are changed according to the vehicle-width-direction mounting position of the steering **6** and the operation direction of the steering **6**, and the deceleration torque and the acceleration torque are set based on the additional deceleration and the additional acceleration after the change. In this embodiment, the deceleration torque and the acceleration torque are indirectly changed according to the mounting position and operation direction of the steering **6**. In another example, the deceleration torque and the acceleration torque may be directly changed according to the mounting position and operation direction of the steering **6** without changing the additional deceleration and the additional acceleration.

(Modification 3)

Although in the above-described embodiment, the vehicle posture control is executed based on the steering angle and the steering speed, in another example, the vehicle posture control may be executed based on a yaw rate, lateral acceleration, yaw acceleration, or lateral jerk, instead of the steering angle and the steering speed.

REFERENCE SIGNS LIST

1 vehicle
4 engine

5 steering apparatus
6 steering wheel
8 steering angle sensor
10 accelerator opening sensor
12 vehicle speed sensor
13 acceleration sensor
14 controller
16 brake apparatus
18 brake control system
41 throttle valve
42 injector
43 spark plug
DS driver seat
G center-of-gravity position #

The invention claimed is:

1. A vehicle control method for controlling a vehicle in which a front wheel is driven by a prime mover, the vehicle control method being characterized by comprising:

a basic torque setting step of setting basic torque to be generated by the prime mover, based on an operational state of the vehicle;

an acceleration torque setting step of setting acceleration torque, based on a reduction in steering angle of a steering apparatus mounted on the vehicle;

a torque generation step of controlling the prime mover so that torque based on the basic torque and the acceleration torque is generated; and

an acceleration torque changing step of changing the acceleration torque, based on a vehicle-width-direction mounting position of a steering wheel of the steering apparatus and an operation direction of the steering wheel when the steering angle is reduced.

2. The vehicle control method according to claim 1,

wherein the vehicle is a right-hand drive vehicle in which the steering wheel is mounted on a right side relative to a width-direction center of the vehicle, and

in the acceleration torque changing step, when the steering angle is reduced, in a case where the steering wheel is operated in a direction of causing the vehicle to turn left, the acceleration torque is reduced compared with in a case where the steering wheel is operated in a direction of causing the vehicle to turn right.

3. The vehicle control method according to claim 1,

wherein the vehicle is a left-hand drive vehicle in which the steering wheel is mounted on a left side relative to a width-direction center of the vehicle, and

in the acceleration torque changing step, when the steering angle is reduced, in a case where the steering wheel is operated in a direction of causing the vehicle to turn left, the acceleration torque is increased compared with in a case where the steering wheel is operated in a direction of causing the vehicle to turn right.

4. A vehicle control method for controlling a vehicle comprising a braking apparatus that adds braking torque to a wheel, the vehicle being in a state of being braked by this braking apparatus, the vehicle control method being characterized by comprising:

an acceleration torque setting step of setting acceleration torque, based on a reduction in steering angle of a steering apparatus mounted on the vehicle;

a torque generation step of controlling the braking apparatus so that torque based on the acceleration torque is generated; and

an acceleration torque changing step of changing the acceleration torque, based on a vehicle-width-direction mounting position of a steering wheel of the steering apparatus and an operation direction of the steering wheel when the steering angle is reduced.

5. A vehicle system for controlling a vehicle, the vehicle system being characterized by comprising:

a prime mover that drives a front wheel of the vehicle;

a steering apparatus including a steering wheel for steering the vehicle;

a steering angle sensor that detects a steering angle of the steering apparatus;

an operational state sensor that detects an operational state of the vehicle; and

a controller that controls the prime mover,

wherein the controller is configured to:

set basic torque to be generated by the prime mover, based on the operational state detected by the operational state sensor;

set acceleration torque, based on a reduction in the steering angle detected by the steering angle sensor;

control the prime mover so that torque based on the basic torque and the acceleration torque is generated; and

change the acceleration torque, based on a vehicle-width-direction mounting position of the steering wheel and an operation direction of the steering wheel when the steering angle is reduced.

6. A vehicle system for controlling a vehicle, the vehicle system being characterized by comprising:

a braking apparatus that adds braking torque to a wheel of the vehicle;

a steering apparatus including a steering wheel for steering the vehicle;

a steering angle sensor that detects a steering angle of the steering apparatus; and

a controller that controls the braking apparatus,

wherein in a state where the vehicle is braked by the braking apparatus, the controller is configured to:

set acceleration torque, based on a reduction in the steering angle detected by the steering angle sensor;

control the braking apparatus so that torque based on the acceleration torque is generated; and

change the acceleration torque, based on a vehicle-width-direction mounting position of the steering wheel and an operation direction of the steering wheel when the steering angle is reduced.

7. An apparatus for controlling a vehicle comprising a steering apparatus comprising a steering wheel, the vehicle being configured as a left-hand drive vehicle in which this steering wheel is mounted on a left side relative to a width-direction center of the vehicle, the vehicle control apparatus being characterized by comprising:

vehicle posture control means that adds, when a steering angle of the steering apparatus is reduced, acceleration to the vehicle to thereby control a vehicle posture; and

acceleration changing means that changes the acceleration to be added by the vehicle posture control means, based on an operation direction of the steering wheel when the steering angle is reduced.

* * * * *